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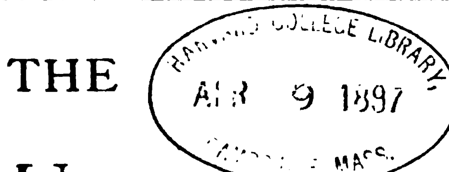
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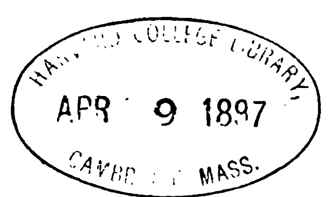
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KANSAS UNIVERSITY QUARTERLY.

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Diptera Brasiliana.

BY S. W. WILLISTON.

PART IV.

Paramyia, gen. nov.

Front broad, plane, bristly on the sides, the bristles extending nearly to the antennæ; two reclinate ocellar bristles present. Antennæ short, the third joint broader than long, with a dorsal, finely pubescent arista. Face short, receding in profile, gently concave, the oral margin slightly protuberant; a vibrissal bristle present on each side. Cheeks narrow, with a row of short bristles on the inferior margin. Proboscis as long as the body; slender, with a hinge near the middle. Palpi elongate, projecting beyond the antennæ; broad, flattened, with a few bristles near their tip. Eyes round, bare. Mesonotum with prescutellar bristles, but no anterior centrodorsal ones. Scutellum large, with four strong bristles, the median ones remote from each other. Abdomen oval, composed of five visible segments, of which the fifth is the longest. Legs not elongate; provided with short hair; all the tibiæ without preapical bristle. First longitudinal vein of the wings very short, the auxiliary vein wholly rudimentary; the costa continues to the tip of the third longitudinal vein; anterior cross-vein situated near the base of the wing and before the tip of the first vein; posterior cross-vein wanting; second basal and the anal cells very small and indistinct, but complete; sixth vein imperceptible; second and third veins nearly parallel, the former gently concave anteriorly; third and fourth veins gently divergent.

This genus differs from *Phytomyza* in the extraordinarily developed proboscis and palpi.

Paramyia nigra, n. sp.

Female. Black. Front opaque, with a long, shining triangle, reaching nearly to the front border. Face more yellowish; in some reflections silvery on the sides. Proximal portion of the proboscis piceous; distal portion yellowish. Thorax shining: mesonotum with rather abundant, short, black hair. Abdomen less shining than the mesonotum. The knees narrowly, the front and middle tibiæ and tip of the hind tibiæ, and all the tarsi yellow. Wings tinged with brownish. Length 2½ mm.

One specimen, Grenada, H. H. Smith.

Beckeriella, gen. nov.

Front very broad and short; a single, small, fronto-orbital bristle present on each side. No bristle on the second joint of the antennæ; arista pectinate. Face about one-third the width of the head; flattened and receding on the upper half, the lower half or third projecting; with one or two small bristles on each side; clypeus prominent. Mesonotum without bristles save one on each side in front of the scutellum; hair very short, the acrostichal ones in two rows. Scutellum much swollen, with a long projecting spine on each angle, into which is inserted a bristle. Abdomen broad and arched; roughened; first segment very short, the fifth and sixth (female) together about equal to two-thirds the length of the fourth. Claws curved; pulvilli present. Third and fourth longitudinal veins of the wings convex anteriorly, the fifth ventricose posteriorly; the costal vein reaches to the fourth vein. Eyes bare. Oral opening small.

This genus has not a little resemblance to the following, and also to *Lytogaster*, from both of which it will be easily distinguished by the structure of the head, as well as by other characters. The male probably has only three visible abdominal segments.

It gives me pleasure to dedicate this genus to Mr. Theo. Becker, who is doing work of much value to American students in dipterology.

Beckeriella bispinosa.

Ephydra bispinosa Thomson, Eugenies Resa, 593.-Rio de Janeiro.

Female. Front brown pollinose, opaque. Face moderately shining black. Antennae reddish yellow. Cheeks very narrow. Mesonotum shining, somewhat metallic black, with indistinct stripes of fine white pubescence. Halteres black. Pleuræ shining black; finely whitish or yellowish pubescent. Abdomen moderately shining, somewhat metallic black, with delicate white pubescence, leaving the narrow hind margin of the third and fourth segments shin-

ing, with a transverse, oval, white-pollinose spot before the hind margin. Legs black; all the tibiæ and tarsi reddish yellow, the terminal joints of the latter darker colored. Wings variegated, brownish and subhyaline, with dark brown clouds on the cross-veins; tip of the first vein and the nearly contiguous costa light yellow; a similar yellow spot is also seen on the costa a little beyond the humeral cross-vein. Length 3 mm.

One specimen, Rio de Janeiro.

Gastrops, gen. nov.

Front broad; plane between the orbital grooves, smooth and a little depressed; on either side with two fronto-orbital bristles, inserted close together. Second joint of the antennæ without anterior bristle; third joint about twice as long as wide; arista with pectinations above. Oral opening of moderate size; clypeus projecting. Face with a large, protuberant gibbosity, below which the profile is nearly vertical; on either side with a row of hairs close to the eyes, of which the upper ones are bristle-like. Eyes nearly round, bare. Cheeks in width equal to nearly one-half the vertical diameter of the eyes. Mesonotum convex; a single bristle present on each side in front of the scutellum. Scutellum convex, with a small tubercle on each posterior angle, from which arises a bristle. Abdomen broad, strongly convex; scrobiculate; first segment in both sexes, and the fifth in the male very short, giving the appearance in this sex of a triarticulate abdomen. All the tibiæ with a row of bristle-like hairs on the outer side. Claws curved; pulvilli present. The costa attains the tip of the fourth longitudinal vein; third vein gently convex anteriorly; fifth vein nearly straight; third section of the costa about two-thirds the length of the second.

Notwithstanding the absence of the spine on the second antennal joint, this genus and the preceding will both find their most natural position in the vicinity of *Hecamede*.

Gastrops niger, n. sp.

Male, female. Body shining, somewhat metallic, black. Antennæ red, the third joint at the tip and on the upper part black. Face on the lower part with a fine, light yellow pubescence. Mesonotum with indistinct indications of two longitudinal stripes and with short black hairs. Abdomen somewhat greenish, shining. All the tibiæ and tarsi, except the terminal joints of the latter, red or yellow. Wings tinged with brownish. Length 2½-3 mm.

Twenty specimens, Grenada and Rio de Janeiro, H. H. Smith.

Allotrichoma abdominale Williston, Dipt. St. Vincent, 398.

This species was placed in the genus *Hecamede*, notwithstanding the imperfect description given by Loew of the genus, by reason of its similarity to the European H. *lateralis* Loew, as shown by the description. Becker has since separated this species as the type of his genus *Allotrichoma*. This species agrees in nearly all respects with the figure and description given by Becker, and I am still in doubt of the identity. As the additional species described by Becker show a very close resemblance, it is very probable that the present is not the same as *laterale*. The peculiar bristles on the hind tibiæ of the male are present in this species, but I do not observe the hypopygial appendages figured by Becker. I have since examined typical specimens of *A. abdominale* from Brazil.

Ilythea flavipes Williston, Dipt. St. Vincent. 403.

My doubts concerning the location of this species are dissipated by the figures and descriptions given by Becker of the type and only other known species, *I. spilota* of Europe. The species is a true *Ilythea*, differing from *spilota* most especially in the short second longitudinal vein of the wing. This species I have also from Rio de Janeiro.

Psilopa aciculata Loew, Monogr. i, 142; Williston, Dipt. St. Vincent, 394, pl. xii f. 142.

Specimens of this species from Rio de Janeiro agree with others from St. Vincent and Grenada.

Psilopa nigrimana Williston, Dipt. St. Vincent, 363.

Several specimens from Brazil agree with the type specimens.

Psilopa metallica Schiner, Novara, Diptera.

Face narrow, not projecting in profile, shining metallic green, with a single bristle on each side below; on either side a row of slight inequalities. Antennæ yellow; arista with about eight rays. Front shining green, very finely aciculate. Scutellum more purplish, with four strong bristles. Pleuræ shining green and black. Abdomen deep metallic green or brassy, the fourth segment about as long as the two preceding together. Legs black; the knees and all the tarsi yellow. Wings yellowish, the immediate root blackish; second and third sections of the costa of nearly equal length. Length 2 mm.

There are some discrepancies from Schiner's description, as will be seen, but I hardly doubt the identity.

Brachydeutra argentata Walker, Dipt Saund. (*Notiphila*.)

Brachydeutra dimidiata Loew, Monogr. etc. i, 163.

This species seems to have a wide distribution; I have it from Brazil, Bolivia, Paraguay, Grenada and Kansas.

Scatella stagnalis Fallen, etc.

Scatella obscura Williston, Dipt. St. Vincent, 403.

I believe that the species described by me is identical with this European species, also recorded from Greenland. I have it also from Brazil.

Paralimna obscura, Williston, Dipt. St. Vincent, 390.

Specimens from Brazil agree with the types.

Paralimna multipunctata Williston, Dipt. St. Vincent, 390.

Numerous specimens from Brazil. In some there is a distinct cloud on the cross veins. Notwithstanding the absence of a stump of a vein, I am not sure that this species is not identical with *P. appendiculata* and probably also *P. secunda.*

Notiphila bellula Williston, Dipt. St. Vincent, 390.

Numerous specimens from Brazil.

Notiphila pulchrifrons, n. sp.

Female. Front with a slender, silvery white stripe or triangle in the middle, with the immediate region of the ocelli brown; on either side a broader stripe convergent toward the middle, opaque black; outside the black stripe the narrow orbits are brown. Antennæ black; arista with about ten rays. Face much longer than broad, only moderately receding in profile, nearly straight and with a rounded carina on the upper part; light opaque yellowish grey in color. Mesonotum opaque dark brown, with two, narrow, more yellowish stripes, and, exteriorly, two elongated spots, or an interrupted stripe. The narrow lateral and anterior margins of the mesonotum white. Pleuræ silvery grey, with an elongated brown spot immediately below the noto-pleural suture. Abdomen dark brown, opaque, with a narrow medium stripe and the posterior angle of all the segments silvery or bluish grey. Legs black, the four posterior tibiæ and tarsi reddish. Wings lightly tinged with brownish. Length 4 mm.

Four specimens, Brazil, H. H. Smith. In some specimens the grey of the abdomen forms complete cross-bands.

Notiphila striata, n. sp.

Female. Front yellowish grey, the small ocellar triangle brown. Face straight and receding in profile, with a depression below each antenna; uniformly opaque yellowish grey in color. Mesonotum yellowish grey, opaque, with five narrow, brown stripes;

the middle stripe is geminate or forked posteriorly; the next outer stripe on each side ends a little beyond the middle, while the outermost ones are abbreviated both in front and behind. Pleuræ yellowish grey, with brown spots. Abdomen with four series of more or less confluent, coffee-brown spots on a bluish grey ground, narrowly separated by a stripe; posteriorly there are minute brown spots in addition. Legs black, the tip of the femora, the tibiæ and tarsi yellow, the front and middle tibiæ with brown rings. Wings tinged with brownish. Antennæ reddish yellow, the third joint blackish above. Length 4 mm.

Two specimens, Brazil.

Ochthera regalis, n. sp.

Male. Front much narrowed below, the sides concave; the large triangle in the middle sub-shining black, the orbits opaque, for the most part black. First two joints of the antennæ blackish, the third light yellow. Face much narrowed in the middle, where the width is scarcely greater than the length of the antennæ; in profile scarcely projecting beyond the eyes; longitudinally convex, with a low, flat tubercle in the middle, below which the color is metallic golden. Mesonotum in the middle with a broad purple stripe, continuous to the tip of the scutellum, and widened at the front margin: on either side of the stripe a narrow, white-pollinose stripe, reaching to the angles of the scutellum and turned outward in front to the humeri; exterior to the white stripe are two oval spots of a brown color, partly separated by a triangular white spot at the suture; lateral margins of the scutellum shining black. Pleuræ black, with an oblique, white-pollinose stripe. Abdomen shining, somewhat metallic, green-black. Legs black; the front tibiæ and tarsi, save the terminal joints, yellow; the four posterior tibiæ, the proximal portion of the dilated hind metatarsi and the terminal joints of the tarsi brown or brownish yellow. Front femora much dilated, their outer side whitish. Wings nearly hyaline. Length 5 mm.

Female. Face not wider in the middle than the length of the third antennal joint, without indication of the flattened tubercle: a brassy stripe in the middle, separated from the narrow whitish orbits by a fine line.

Two specimens, Rio de Janeiro. The oral opening is very small, and the cheeks are exceedingly narrow.

Ochthera humilis, n. sp.

Male, female. . Front short, only a little inclined; the large ocellar triangle shining black, the orbits opaque black. Antennæ dark

brown. Face at its narrowest place more than one-fourth of the width of the head, distinctly prominent in profile, the lower portion convex and receding; wholly opaque yellowish grey, except a small oval, metallic spot in the middle. Mesonotum greyish; somewhat metallic bronze in some reflections, with four, narrow, bronze stripes. Scutellum shining black on the flat portion: grayish yellow on the margins. Pleuræ black, with the usual oblique greyish stripe. Abdomen shining metallic, greenish black; in the male at least very distinctly pruinose; in the middle anteriorly with brownish spots. Legs black; all the femora greyish outwardly; all the tarsi reddish; front femora moderately thickened; hind metatarsi elongated and thickened, more so in the male. Wings nearly hyaline. Length 5 mm.

Two specimens, Rio de Janeiro.

Parydra humilis, n. sp.

Female. Front moderately shining, somewhat metallic, nearly uniform in color with some brownish dust. Antennæ black throughout; arista distinctly pubescent on the basal part. Face gently convex, nearly vertical on the lower part: rather thickly greyish and brownish pollinose; on either side with a moderately strong bristle and one or two shorter below it. Cheeks in width equal to more than half the diameter of the eyes. Mesonotum and scutellum shining, metallic black, with thin brownish dust; the acrostical hairs are bristle-like. Abdomen black, only a little shining. Pleuræ opaque greyish; on the upper part of the mesopleuræ sub-metallic. Legs yellow, the two distal joints of the tarsi black. Wings tinged with brownish, with an indistinct cloud on the cross-veins: the second section of the costa nearly three times the length of the third; second vein not appendiculated; third and fourth veins nearly parallel, or very slightly convergent. Length 4 millim.

Two specimens, Rio de Janeiro (Smith). The male specimen has the antennæ somewhat reddish, and the abdomen is more shining metallic in color. From *P. bicuspidata*, Karsch the only other described South American species, the present differs in the straightness of the third vein.

Lipochæta Coquillett.

The limits of the families Ephydridæ, Drosophilidæ, Oscinidæ, Agromyzidæ and Geomyzidæ are not at all what one might wish for classificatory purposes. Becker would exclude the genus *Aulacigaster* from the Ephydridæ. Schiner places it among the Drosophilidae, but does not greatly object to its location with either the

Ephydridæ or Geomyzidæ. Mik refers it to the Ephydridæ and Loew to the Agromyzidæ; all of which views render it clear that the definition of these families is not very exact. Through the kindness of Mrs. Slosson I have recently had the opportunity to examine the type species of *Lipochaeta* Coq. Its habitus is very foreign to the Ephydridæ and its union with it will require the abandonment of the families Oscinidæ and Agromyzidæ. No Ephydrid that I know of lacks bristles, while both of these latter families have numerous forms without them. The face is too short, the antennæ too different in structure to belong with the Ephydridæ. Moreover the pollinose body and white wings, while, not absent among Ephydridæ, are not at all common. All these characters, however, are found in species related to *Leucopis*, *Cryptochætum*, *Rhicnoessa*, etc. If it is a representative of a new sub-family, at least half a dozen other genera, like *Cryptochætum*, *Canace*, *Aulacigaster*, *Diastata*, *Leiomyza*, etc. will require the same treatment. I prefer to place it among the Ochthiphilinæ in the vicinity of *Rhicnoessa*. Its relation with *Lipara* can not be overlooked.

I may add to the description that the anal cell is incomplete, the costa is continued to the tip of the fourth vein, and the last abdominal segment (? female) is conical and elongated; the first vein does not reach the middle of the wing, the third and fourth veins are gently convergent; the second vein is long; and the ocelli are not remote from the vertical margin, as figured.

Physogenua vittata Macquart, Dipt. Exot. Suppl. iii, 60. pl, vii, f. 2; Becker, Berl. Ent. Zeitschr. xl, 255, pl. i, ff, 4, 5. *Lauxania variegata* Loew, Dipt. Amer. Sept. Centur. i, 83; Schiner, Novara Dipt. 277. *Sciomyza obscuripennis* Bigot, Ramon de la Sagra, 326 (Roeder, Stett. Ent. Zeit. 1885, 349).

Numerous specimens, Brazil.

Physogenua ferruginea Schiner, Novara Exped. 277. *Sapromyza urinc* Giglio-Tos, Bollet di Mus. Anat. Comp. di Torino, viii, 158; Ditt. del Messico, iii, (*Physogenua*).

Numerous specimens from Chapada, Brazil, agreeing quite with the descriptions.

"Genus incertum," Becker, Berl. Ent. Zeitschr. xl, pl. i, f. 12.

Numerous specimens from Brazil agree well with the characters given for this genus by Becker, and it seems probable that the species is identical with the one he had.

"Genus incertum" nigra Williston, Dipt. St. Vincent, 379, pl. xiii, f. 133, (*Physogenua*.)

Specimens of this species, referred by me to *Physogenua*, to which

the relationship is the nearest, are not uncommon in Brazil, apparently. The figure of the head given by me is incorrect, in that the clypeus is not distinguished from the lower part of the face.

Sapromyza rubescens Macquart. Dipt. Exot. ii, 3.345; Schiner, Novara Dipt. 279; F. Lynch A., An. Soc. Cient. Arg. xxxiv, 288. *Sapromyza latelimbata* Macquart, Dipt Exot. Suppl. v, 120, pl. vi, f. 18 (Lynch).

Male, female. Head yellow. Front less than one-third of the width of the head, a very little wider below, with the usual strong bristles; the proclinate ocellar bristles small. Antennæ light reddish yellow, the third joint oval, rather more than twice as long as broad; arista black, moderately plumose. Palpi yellow. Thorax yellow, the mesonotum light reddish yellow; scutellum plane. Abdomen brownish yellow or yellowish brown. Legs yellow; all the tarsi (except the middle metatarsi), and the distal portion of the hind tibiæ brownish. Wings lutescent hyaline, the costa to beyond the fourth vein, and moderately broad clouds on the cross-veins, dark brown; the brown of the marginal cell for the first half does not quite reach the second vein; first vein very short, its termination about opposite the first section of the third vein; ultimate section of the fourth vein only a little longer than the penultimate section. Length 5 millim.

Eight specimens, Chapada and Rio de Janeiro, Brazil.

Sapromyza geminata Fabricus, Syst. Antl, 331, (*Dictya*); Wiedemann, Auss. zw. Ins. ii, 450; Schiner, Reise der Novara, Dipt., 279; F. Lynch A., An. Soc. Cient. Arg. xxxiv, 269, 299. *Sapromyza plagosa* Giglio-Tos, Bollet di Mus. Zool. ed Anat. Comp. di Torino, viii, 158; Ditt del Messico, iv.

Wiedemann speaks of only two spots in the apical clouding of the wings; in the specimens before me there are three and sometimes four.

Sapromyza contigua (Fabr.) Wiedemann, Auss. zw. Ins. ii, 450; Schiner, Novara Dipt. 279; F. Lynch A., An Soc. Cient. Arg. xxxiv, 290.

Two specimens Chapada, agreeing well with the description. A third specimen from the same place differs in having the abdomen black. A fourth specimen, from Rio de Janeiro is perhaps specifically different. It agrees in everything save that the fourth vein is clouded nearly to the cloud of the cross-vein and the margin of the scutellum has two black spots.

Sapromyza macula Loew, Centur. x, 82; Williston Dipt. St Vincent, 380.

Numerous specimens from Brazil.

Sapromyza xanthiceps, n. sp.

Female. Face shining yellow, with two narrow stripes, converg-

ent anteriorly, and on either side contiguous with the eyes; on the outer side of the two lower bristles a large round spot, all deep brown. The front at the vertex is as broad as its length; proclinate ocellar bristles small. Face, cheeks, proboscis and palpi light yellow. Face on the sides lightly silvery pollinose. Cheeks and occiput with black hairs. Antennæ light reddish yellow, the third joint about three times as long as wide; arista black, moderately long plumose. Thorax yellow, the mesonotum and scutellum light reddish yellow. Scutellum plane. Abdomen yellow or brownish yellow, the second and following segments each with a narrow posterior black band. Legs yellow; the distal end of all the tibiæ and the tarsi (except the middle metatarsi) brown. Wings luteous hyaline; the costal, marginal, the anterior part of the submarginal from in front of the cross-vein, and its distal part wholly, the distal part of the first posterior, extending into the second posterior cell, broad clouds on the cross-veins and a narrower cloud on the fifth vein dark brown: first longitudinal vein very short, terminating about opposite the middle of the first section of the third vein; penultimate section of the fourth vein about two-thirds of the length of the ultimate section. Length 6-6½ mm.

Two specimens, Piedra Blanco, Brazil.

Sapromyza picrula, n. sp.

Male, female. Head opaque light yellow. Front with the sides parallel, a little more than a third of the width of the head; a rounded brown spot on either side at the insertion of the lower bristle, apparently the lower one of an obsolete stripe. Proclinate ocellar bristles strong. First two joints of the antennæ blackish: third joint light reddish yellow, more than three times as long as wide; arista black, moderate long plumose. Face at the middle of each lateral depression with a brown spot, connected by a slender line with a median spot above the oral margin, forming a U or V shaped figure. Proboscis and palpi black. Mesonotum light ochraceous yellow, with two, narrow, median stripes or slender spots, and, on each side with a number of spots, all light brownish or reddish. A single bristle on each side in front of the a prescutellar row. Scutellum plane, with a large black spot on each lateral margin. Abdomen yellow, with three series of large black spots. the middle ones forming a stripe; in some specimens the abdomen appears to have an irregular black band on the anterior part of each segment. Legs deep brown; the base of the front and middle tibiæ, the middle tibiæ, save the distal end, and the first one or two joints of the four posterior tarsi light yellow. Wings smoky

hyaline; the distal portion from the tip of the first vein obliquely across to the back of the fourth vein brown; posterior cross-vein less deeply clouded; termination of the first vein before the anterior cross-vein; ultimate section of the fourth vein about twice the length of the penultimate section. Length 5 mm.

Six specimens, Chapada. A number of other specimens from the same locality differ as follows: Color light yellow; front with two dark brown stripes, not enlarged into a spot below. Face with a small V-shaped brown spot below. Mesonotum with six, narrow, light brownish stripes, the four in the middle more approximated; just outside them, and between them and the lateral stripe, an incomplete stripe back of the suture. Spots on the scutellum smaller. Legs yellow, front femora on the outer and distal part, hind femora to the immediate tip, and the distal joints of all the tarsi brown or brownish, color of the wings much less intense, being brown only on the outer part of the costa.

Sapromyza exul Williston, Dipt. St, Vincent.

A single specimen from Rio de Janeiro.

Sapromyza bipunctata Say, Compl, Wr. 367-Mexico.

A specimen from Rio de Janerio may be of this species. The head is yellow, including the antennæ. The arista is bare. The abdomen is of a uniform brownish color, perhaps the effect of dessication. The wings have a broad brown costal border, extending around the tip to beyond the fourth vein; a small projection from it extends across the middle of last section of the third vein. There is a narrow, dark brown cloud on each cross-vein.

Sapromyza lupulinoides, n. sp.

Male. Front yellowish; on the lowermost part a narrow transverse band light yellow, above which there is a black band of a little greater width, the upper margin of which is not sharply defined; a small black spot on either side of the root of the antennæ. Antennæ yellow; third joint about three times as long as wide; arista short plumose, or rather, long pubescent. Face light greyish yellow, with a blackish spot in the middle below. Thorax black, but whitish pollinose, giving a slaty color; scutellum dark brown, the immediate base grey. Abdomen uniformly reddish yellow or light ferruginous in color. Legs black, the front tarsi at the base yellowish. the four posterior tibiæ and tarsi yellow, save that the tip of the tibiæ is blackish. Wings uniformly yellowish. Length 4 millim.

One specimen. This species is closely allied to *S. lupulina* of Europe and North America, but will be at once distinguished by the short plumose arista.

Stegana.

Specimens of two or three species of this genus, from Brazil, evidently indicate close colorational resemblances as characteristic of the genus. Among them I believe I recognize in an imperfect specimen, *S. tarsalis* Will., which may be identical with *S. flavipes* Wied. Another species has the front much depressed and broad, the face and cheeks yellow and the palpi slender, but otherwise agrees with *S. hora* Will.

Drosophila opaca Will. Dipt. St. Vincent, 411.

Specimens from Brazil agree well with the types.

In a recent number of the Wiener Ent. Zeitung, Professor Mik, in calling attention to the preoccupation of the name *Sackeniella* mihi, states that Osten Sacken had shown its identity with *Curupira* Müller. I was quite familiar with Osten Sacken's paper when I proposed the name, and I think if Professor Mik will again examine the article, he will see that Osten Sacken did not consider the genera identical. That *S. rufescens* was included in the forms described by Müller as *C. torrentium* is probably true, as Osten Sacken shows, but that *C. torrentium* and *S. rufescens* are identical, can not be possible. "If my supposition be correct, *S. rufescens* would be the first species described in the mature state among the group of larvæ studied by Dr. F. Müller. The question of the other forms must remain open until we likewise obtain mature specimens of them."

Notwithstanding Müller's deserved repute as a naturalist, no dipterologist can accept the conclusions that *C. torrentium* had dimorphic females—one mellisugous and holoptic, the other sanguisugous and dichoptic. Certainly no such extraordinary conclusion can be accepted until such females have actually been bred. Prof. Mik will see by turning to Dr. Osten Sacken's paper (p. 162) the generic definition he has given for *Snowia* and *Curupira*.

Restoration of Oreodon Culbertsonii Leidy.

BY ALBAN STEWART.

(With Plate I.)

Among the material of the Oreodontidæ of the Kansas Museum are two remarkable specimens of *Oreodon culbertsonii*, collected by Dr. Williston in the White River Miocene of eastern Wyoming. The two specimens are lying in one slab, close together, the one, an older individual, partly overlying the other. The skeleton of the older animal lies with nearly all its bones in place, the only ones displaced being five cervical and six anterior dorsal and the caudal vertebræ. The other specimen is apparently complete, though some of the bones are partly concealed yet in the matrix. The two animals together furnish nearly every bone of the skeleton, the only ones left in doubt being the last rib, the terminal caudal vertebræ and the fifth digit of the front foot.

A restoration based upon this remarkably perfect material was nearly completed before I obtained access to the very thorough paper by Professor Scott on the same animal, in the Morph. Jahrbuch, lxvi, pp. 319–395, and, notwithstanding that the restoration given by him is in most respects excellent, I have thought it worth while to publish the present one, inasmuch as there are certain errors in Professor Scott's restoration, due to the insufficiency of the material upon which it was based. The present paper is, therefore, in a measure corrective of his paper, but for the most part supplementary.

The principal corrections here made are in the length of the tail, the shape of the pelvis, the position of the acromion process of the scapula and the presence of the metacromian, the form of the posterior superior angle of the scapula, and in the number of dorsal and lumbar vertebræ, as well as the length of the posterior ribs.

The caudal vertebræ are scattered and largely missing in the larger individual, but are nearly all in place in the younger skeleton, one or two at the tip being absent. There is not much difference in the size of the two individuals, and a careful comparison of

the other bones shows very clearly the precise degree of enlargement required for the restoration. Scott suspected that the short tail figured by him might be incorrect, as appears from the following: "Obgleich kein mir bekanntes Exemplar von Oreodon einen vollstaendig erhaltenen Schwanz besitzt beweisen doch die vielen vorhandenen Wirbeln dass das Thier einen sehr langen Schwanz gehabt hat, eben so lang, wahrscheinlich, wie bei Anoplotherium." (Scott, l. c.)

The general form of the ilium is somewhat more slender than is indicated by Dr. Scott's figure, the superior border is slightly excavated, instead of arched, and the angles formed with the anterior and posterior borders are rounded and not acute. The ischium also presents a prominent tuberosity not shown in the figure, and which resembles that of the dog more than of the Artiodactyla.

The spine and acromial process, instead of being directed slightly backward, are curved gradually forward, and at the lower extremity project beyond the anterior border of the scapula. The superior portion of the metacromian process is wanting in the specimens, but there is sufficient remaining to indicate a considerable development in this species.

All the lumbar vertebræ and seven of the dorsals are in place. The sixth presacral is a true lumbar, showing no rib-facet, and it is provided with long, broad, transverse processes.

The ninth, tenth and eleventh ribs are in place, from which it is evident that the posterior ones are longer than were figured by Scott.

Gypsum in Kansas.

BY G. P. GRIMSLEY.

With Plates III, IV, V, VI.

HISTORICAL INTRODUCTION.

Gypsum (sulphate of lime), from two Greek words γη=earth, and εψω=to concoct, is a mineral which has attracted attention from very early times. The transparent variety known as selenite was used by the ancients as a substitute for glass in windows. The best varieties were supposed to be in Upper Egypt and in Syria. It was also in favor for ornamental boxes, and for urns, in which lighted lamps were placed, and so threw a soft light through the apartments. The walls of the temple of Fortuna Seia were made of compact gypsum, and the interior, though without windows, is described as "sufficiently lighted by rays transmitted through the semi-pellucid walls." The writings of Theophrastus show that the Greeks were familiar with the use of plaster of Paris, made from calcining the gypsine stone in making casts. The term alabaster is commonly noted in the ancient writings, and sometimes refers to compact gypsum and sometimes to the stalactite carbonate of lime, so that it is often difficult to tell from the meagre descriptions which is intended.

The earliest account of the use of gypsum as a fertilizer in the ground form known as land plaster is in 1768, when a German clergyman, by name of Mayer, used it with success. After this time there were numerous experiments made to test its efficiency and the faith of the workers along this line gave the appearance of wonderful results. Thus one writes, that "the invariable results of several experiments incontestably prove that there is a most powerful and subtile principle in this tasteless stone, but by what peculiar agency or combination it is capable of forcing vegetation in such an instantaneous and astonishing manner is a mystery which time reserves for others to unfold."

Gypsum in nature occurs in five forms, all of which are found in the State of Kansas. 1. The earthy form, yellow or gray in color,

and composed of loose dust-like particles, rather light in weight, and is formed from solution of gypsum in water. 2. The compact variety, including alabaster and massive gypsum, which is very soft and of specific gravity, 2.2 or near. 3. Fibrous gypsum or satin spar, usually found in thin layers, in form of fine needles or prisms. 4. Foliated gypsum, sometimes massive, but usually in small concretionary masses. 5. Spar gypsum or selenite, found in transparent crystals.

Gypsum is found in Thuringia, Saxony, Norway, at Mont Martre near Paris, Austria, Bohemia, Italy, Egypt, Arabia, Persia, and many other places in the old country. In the United States it is found along an east and west line in central New York, from Oneida county to Niagara; near Sandusky, Ohio; near Grand Rapids and Alabaster Point, Michigan; in Smyth and Washington counties, Virginia; in Alabama and Louisiana; in Iowa, Kansas, Arkansas, Texas, Oklahoma, Indian Territory. Colorado, Montana, Utah, South Dakota, Wyoming, Arizona, Idaho, New Mexico, California. The total amount produced in the United States in 1894 was 239,312 short tons. The State of Kansas* produced that year 64,889 tons, of which all but 647 short tons was calcined, thus standing second to Michigan among the states in quantity mined. The value of this product was $301,884, an excess of $112,264 over Michigan, placing this state first among the states of the Union in value of gypsum products. The value of the Kansas gypsum mined that year was greater than that of all the other states, excepting Michigan. There has been an increase in value of the gypsum products of Kansas of $207,649 in six years, which makes a record the state may well be proud of, and at the present time a very small percentage of the available supply has been taken, so that Kansas gypsum has a promising future.

LOCATION AND DIVISION OF AREA.

The gypsum deposits in Kansas occur in a belt trending northeast-southwest across the state. The belt of exposed rock varies in width from five miles at the north to fourteen in the central part and thirty-six miles near the southern line, with a length of 230 miles.

This area is naturally divided into three districts, which are named from the important centers of manufacture: the northern or Blue Rapids area in Marshall county, the central or Gypsum City area in Dickinson and Saline counties, the southern or Medicine Lodge area in Barber and Comanche counties. These areas ap-

*Statistics from 16th Annual U. S. Geological Survey. 1896.

pear to be separate, but careful mapping shows a number of isolated intermediate deposits which serve to connect at least two of the larger areas. Gypsum is reported from near Randolph and in the reservoir excavation at Manhattan in Riley county. It is worked for plaster at Longford in the southern part of Clay county, and it is found near Manchester in the northern part of Dickinson county. These smaller areas indicate a connection between the northern and central areas.

Gypsum deposits of economic importance are reported from near Peabody in Marion county, while they appear to be absent through Reno, Sedgwick and Kingman counties, where the extensive salt deposits occur. There is thus a break between the central and southern areas which is occupied by salt deposits.

GEOLOGY.

The northern area is located in the Permian beds, consisting of fossiliferous limestones and shales. The central area lies in the Permian, though higher than the northern, while the salt measures to the south occur near the top of the Permian. The southern Kansas gypsum is found in a series of red, sandy shales, called the Red Beds, which probably mark the transition from Permian to Cretaceous. The deposits, therefore, rise geologically from north to south, but they are confined to the Permian formation. The deposits to the south in Indian Territory and Texas are placed in the Permian, while those at the north in Iowa are referred to the Cretaceous.

TOPOGRAPHY.

The northern area shows the remnant of a plateau of 1250 feet elevation now indented by the Blue rivers and their tributaries, yielding a somewhat rugged topography. (This is shown in plate III from photograph at Manhattan with Blue river on right.) The central area lies seventy miles southwest of Blue Rapids, The area is drained by the Smoky Hill river, which flows in an extremely irregular or winding channel north of east, uniting with the Republican river at Junction City, thirty miles away, to form the Kansas. It flows in the middle of a broad valley 1100 feet above sea level and a mile or more in width. Its tributaries in the gypsum area are three or four small creeks—Gypsum, Holland and Turkey—which flow almost directly north. The main water-shed' lies twenty-two miles to the south of the river, and trends nearly east and west, with an elevation of 1500 to 1550 feet. This descends on the south side within eight miles to 1400 feet at the Cottonwood river. The divides between the north flowing creeks have a gradual

slope of about twenty feet to the mile and their sides are deeply indented by erosion. They vary in height above the creek level from 100 to 150 feet. The effect is that of a dissected plateau with irregular surface. A number of small towns are situated along the railroads in the central part of the area, while larger cities are located on the river.

The southern area is situated 120 miles southwest of Gypsum City. The northern part is drained by the Medicine Lodge river, which rises in Kiowa county and flows southeast to Medicine Lodge, where it abruptly turns south and flows into Oklahoma; there it empties into the Salt Fork of the Arkansas river. The southern part is drained by the Nescatunga and its branches. The streams have cut deep channels or canyons in the soft strata which reach 200 feet in depth. The water shed between the two rivers is broad in Comanche county, with an elevation of 2200 feet; but it rapidly narrows to the southeast in Barber county, where its elevation is 2000 feet, descending to 1600 feet in the valley of the Medicine Lodge river within a distance of seven miles. The watershed trends parallel with this river and turns south near the central part of Barber county, still parallel with the river. This region, with its gypsum capped buttes of red clay and shale, possesses a very rugged topography and gives evidence of great erosion. These features are well shown in the photograph of Flower Pot Mound shown in Plate IV, and also in the photograph of the Gypsum Hills, near the town of Medicine Lodge, shown in Plate V.

BLUE RAPIDS AREA.

The first gypsum deposits worked within the state of Kansas were in the northern or Blue Rapids area. In November, 1869, the commissioners laid out the site for the town of Blue Rapids. They carefully investigated the natural resources of the region and recognized the value of the water power of the Blue, and also the value of the gypsum deposits which had been known for some time to exist on the Big Blue about two miles northwest of the town. On selling their various properties they made a reservation along the Blue of 100 rods, including the known outcrop of the beds and extending back from the river for a distance of 320 feet.

About the year 1871 Mr. J. V. Coon, of Elyria, Ohio, came to the new town, and, as the story goes, he burned some of the gypsum and carried it back to Cleveland, where it was pronounced to be of good quality and two car loads were ordered at a good price. He and a brother returned to Blue Rapids in 1872 and built a

frame shed on the east bank of the river, below the town. In an iron kettle, which held about five barrels and which was heated by a stove, they commenced the manufacture of plaster of Paris. Prosperity seems to have attended their work, for in 1875 a stone mill was built by Coon & Son on the west side of the river and the water power of the river was now used for grinding. This mill is now standing, a monument to the commencement of a great Kansas industry. The town, for purpose of encouragement of the new departure, granted them the north half of their reservation, described as extending from a point at the middle of the outcrop and thence north. This mill was operated for nearly twelve years and then the firm unfortunately failed. The mill property and the gypsum grant of fifty robs of outcrop and twenty rods back in the hill, came into the hands of Mr. Sweetland, a business man of Blue Rapids. It was leased to several parties and the mill was run to the year 1889, when the flood caused considerable damage resulting in the abandonment of the mill.

Mr. Hayden, of New York, in 1887 bought the remaining portion of the old reservation and the adjoining Robinson farm. Fowler Brothers bought the farm back of the Sweetland twenty rods limit.

The earlier mining was done by stripping the cover of dirt and shales, and the rock was hauled in wagons to the mill. Later it was brought down the river in flat boats, drawn by a small steam tug.

In 1887 the Fowlers formed the Blue Rapids Plaster Company and built a one and one-half story frame mill of one kettle capacity on the west side of the river at edge of town. The present entry to their mine is fifteen feet above the water level, though the gypsnm bed rock is the bed rock of the river, which is four feet deep at this place. The entry runs east about 350 feet and the gypsum dips west toward the river. Five men are employed at the mine, and the rock is hauled out and up an incline to the railroad where a twenty-five ton car is loaded in two days and hauled to the mill. The gypsum occurs as a gray, mottled rock, with sugary texture, breaking with irregular fracture. The top consists of a layer of white selenite needles forming satin spar, with a thickness of one-fourth to one and three-fourth inches. Throughout the mine are numerous cutters, in which are found perfect, transparent crystals of gypsum, usually of small size.

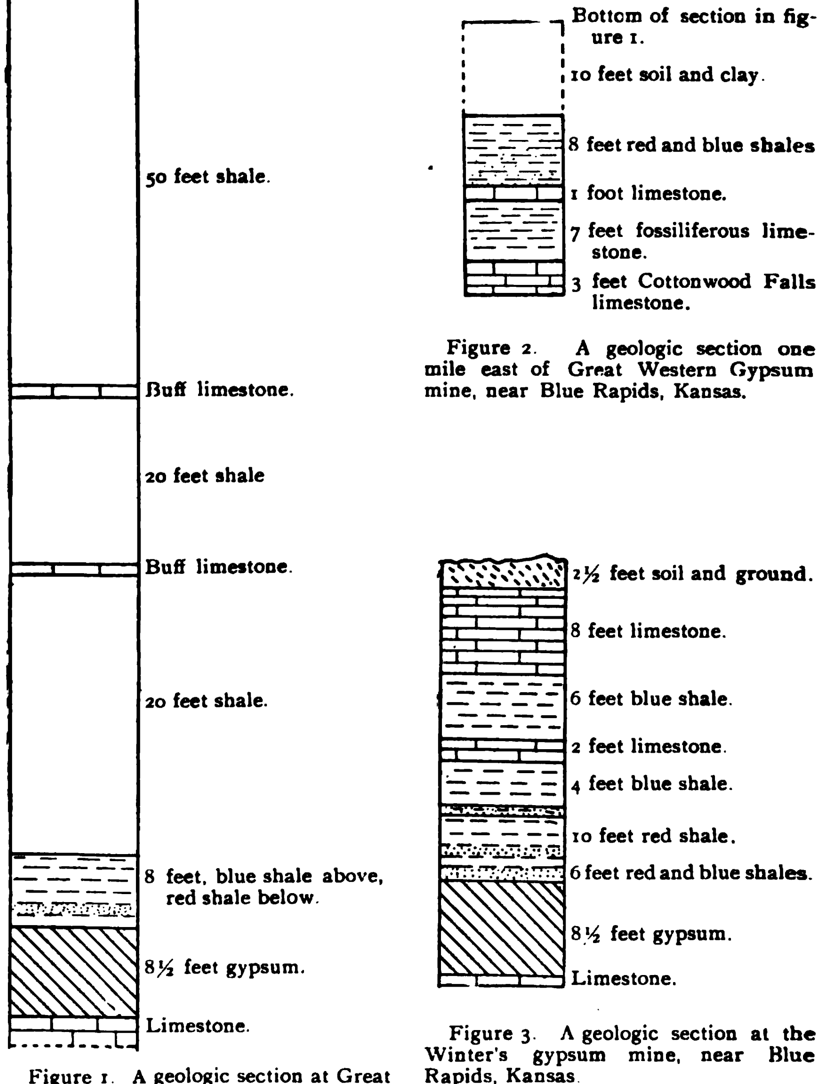


Figure 1. A geologic section at Great Western Gypsum mine, Blue Rapids, Kansas.

Figure 2. A geologic section one mile east of Great Western Gypsum mine, near Blue Rapids, Kansas.

Figure 3. A geologic section at the Winter's gypsum mine, near Blue Rapids, Kansas.

The Great Western mine is located on the side of a bluff, one mile north of the town and forty-five feet above the level of the water in the river. It is two and a quarter miles southeast of the Fowler mine. The entry runs east of north for about 400 feet. In the first 200 feet the gypsum was in round masses, thick at the

middle and running out on the sides, with the trend across the entry and parallel with the slope of the hill. These appear to be old water courses. The thickness of the gypsum layer is the same as at Fowler Brothers' mine, eight and one-half feet, and both rest upon a limestone floor. The section of the hill, which is typical for the region, is given in figure 1. The section given in figure 2 was taken one mile east of the mine, and the top is ten feet lower than the bottom of the first section. The gypsum rock resembles very closely that already described, except there is an absence of the cutters and crystals.

On the banks of the Little Blue, two miles west of town, is located the Winter's mine. The entry runs east and is in the hill about 900 feet. The section, as shown in figure 3, is quite similar to the Great Western mine. The rock does not differ in appearance from other parts of this area.

These three places are the only ones in the northern area where the rock is used, but it outcrops at a number of other localities and is struck in the various wells to the north, south and west of Blue Rapids; but it appears to be absent in the wells to the east.

GYPSUM CITY AREA.

In the northern part of the area, six miles southwest of Solomon City, on Gypsum creek, is located the mine and mill of the Crown Plaster Company, The workable stratum of gypsum is five feet, and it is covered by forty feet of shales and gypsum layers which are much folded and broken. The entry is twenty feet above the water in the creek and is driven 115 feet east with two north entries eighty feet in length. The upper part of the stratum is similar to the northern gypsum, but the lower portion is very compact and is dotted with elliptical crystals of yellowish-brown selenite with the greater length in the direction of the vertical crystal axis(c), as represented in figure 4. The crystals are nearly one inch long and one-half inch wide, and give an appearance somewhat like the bird's eye limestone of the eastern United States.

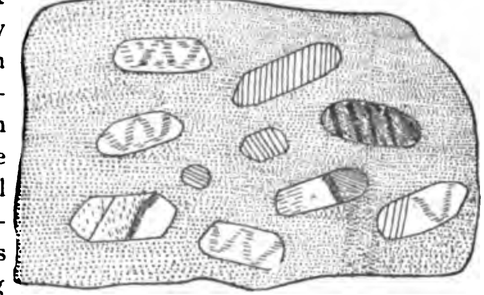


Figure 4. Solid, massive gypsum, containing rounded and irregularly placed crystals of gypsum.

At Hope, twenty miles southeast, is located the only other mine in the rock gypsum in the central area. This is owned by the Kansas Cement Plaster Company, and they now obtain the rock from a fourteen foot stratum at the bottom of an eighty foot shaft. This rock is white, and much of it is traversed by wavy, dark lines, which give a gneissoid appearance, and the plaster made from it is sold under the name of "Granite Cement Plaster." The lower part is compact and contains the rounded crystals of selenite, as in the mine at the north. Through this region there is another stratum five feet in thickness and 100 feet higher, but it is not worked at the present time.

SECONDARY DEPOSITS.

Most of the plaster mills in this central area use the earthy gypsum deposits, which occur at various places in the region. There are five of these known. The first of these was discovered in the spring of 1873, near Gypsum City, by Mr. John Tinkler, in running a fire guard around a field. Two years later he calcined some of the dirt, as it is locally called, in an ordinary thirty-eight gallon kettle and used the plaster in the cellar of his house, where it still remains in good condition. In 1889, he, with others, built a mill at the edge of town, but it is no longer used. The deposit covers an area of twelve acres with an average thick of eight feet. It consists of a loose, granular dirt, of light ash gray color when dry, and it is readily shoveled into cars. It is thus directly calcined with less labor and expense than is the case with the solid gypsum rock.

A number of years after the discovery of this deposit Mr. Gotlieb Heller discovered a similar deposit fourteen miles east near Dillon station. Another deposit is located three and one-half miles southwest of Dillon, and is five feet thick. In Marion county, about six miles south of the last deposit, the Acme Company own a mill and similar deposit which is six to ten feet thick. The Agatite Company have another mill and deposit at Longford, in Clay county, thirty-five miles northwest of the Dillon mill.

All of these deposits lie in low, swampy ground, and strong gypsum springs are usually found in them. In most there is a ledge of rock gypsum at the same level or ten to twenty feet below. The presence of recent shells and bones near the bottom of these deposits shows they are recent in age.

MEDICINE LODGE DEPOSITS.

The southern Kansas gypsum, with its continuation in Oklahoma and Texas, forms the largest area in the United States. Near

Medicine Lodge the rock caps the hills as a layer twenty-five feet thick protecting the underlying soft red beds, thus causing the very rugged topography already described. The red clays and shales below the gypsum contain an interlacing network of selenite and satin spar layers, which have been dissolved out of the solid stratum and carried downward by circulating water. In the western part of the area solution has carved out caves and underground channels, leaving, in many places, natural bridges of gypsum. The rock is snowy white, and the greater portion has a sugary texture, though the lower portion is compact. There are two mills making plaster from this rock. Best Brothers own a mill at the town of Medicine Lodge and manufacture the product known as Keene's cement, or Robinson cement. This mill has been in operation since 1889. The Standard Cement & Plaster Company have a mill west of Sun City and manufacture about eighteen tons of plaster per day. This great gypsum area is practically undeveloped at the present time.

ORIGIN AND AGE.

I have treated this subject quite at length in a recent paper for the Bulletin of the Geological Society of America, which will soon be issued from the press. The central and northern rock strata were deposited in an arm of the sea, cut off from the main ocean in the lower Permian or Neosho epoch. Farther out in the old gulf salt was deposited in large amount and forms today an important addition to the mineral wealth of the state. No salt is now found close to the gypsum, and if it did exist it has been removed by solution. The irregular upper surface of the gypsum shows that there has been solution in some places where large quantities of gypsum rock have been carried away.

The swamp deposits of earthy gypsum have probably been formed by deposit from springs, aided by wash from the hill-sides; and they are recent in age.

The southern gypsum was deposited in a shallow gulf cut off not far from close of Permian time. As in the northern gulf, a salt deposit occurs to the southwest in the Salt Plains district, but no trace is found near the gypsum.

TECHNOLOGY.

There are eleven mills in Kansas engaged in the manufacture of plaster from gypsum, seven use the gypsum rock and four use the gypsum dirt. Nearly the same process is used in all the mills of the northern and central areas, except that the mills using the dirt do not require the crushing machinery. The machinery is manufac-

tured by Butterworth & Lowe, of Grand Rapids, Mich., and also by a Kansas company, the Ehrsam Machine Company, of Enterprise.

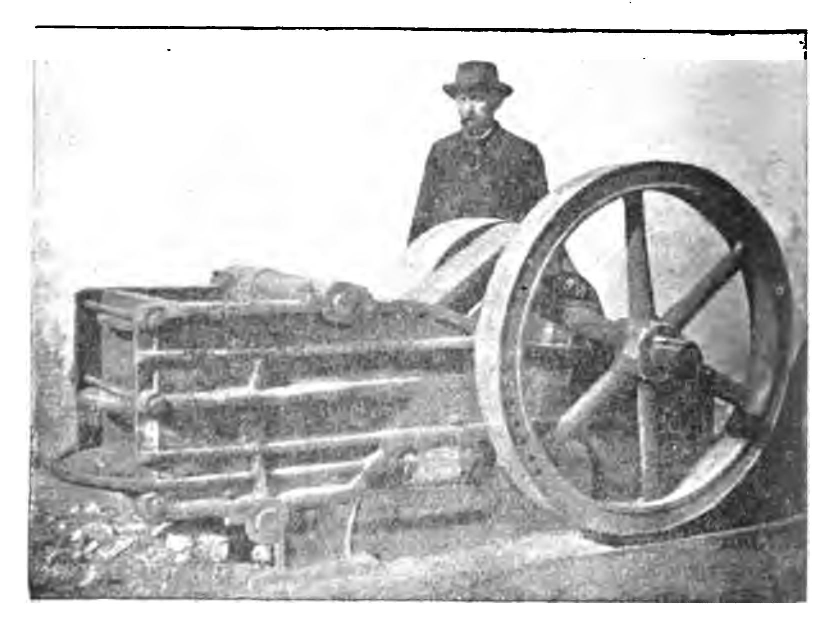


Figure 5. Gypsum Crusher.

On the ground floor is placed the crusher and nipper. The crusher has face plates or jaws of chilled iron, which have a backward and forward crushing motion, and it is operated by steam or water power. Blocks, averaging fifty pounds weight, are thrown into this machine and crushed into pieces about the size of a man's hand. These small masses drop from the crusher into the cracker, which is set in the floor just under the crusher. This machine, with its interior revolving shaft, acts somewhat like a coffee mill and further crushes the gypsum into fragments of the size of small gravel which fall into buckets of a chain elevator, whereby it is raised to a bin on the second floor. From this bin the gypsum particles pass through a spout into an ordinary buhr mill where it is ground into flour. From the buhrs it passes into another chain elevator and is carried to the top of the second story into the storage bin, located just over the kettle. It is then run slowly into the calcining kettle, taking about one hour to fill it to a depth of five feet. The average kettle is eight feet in diameter and six to eight feet deep, surrounded by a wall of stone nearly four feet thick.

Such a kettle holds seven and one-half tons of ground rock, which is calcined in three hours. It loses about one-fourth its weight through loss of water, which passes out the vapor stacks connected with the kettle, so that there remains about six tons of plaster. During the process of calcination the whole mass is stirred by a revolving stirrer, making about fifteen revolutions per minute.

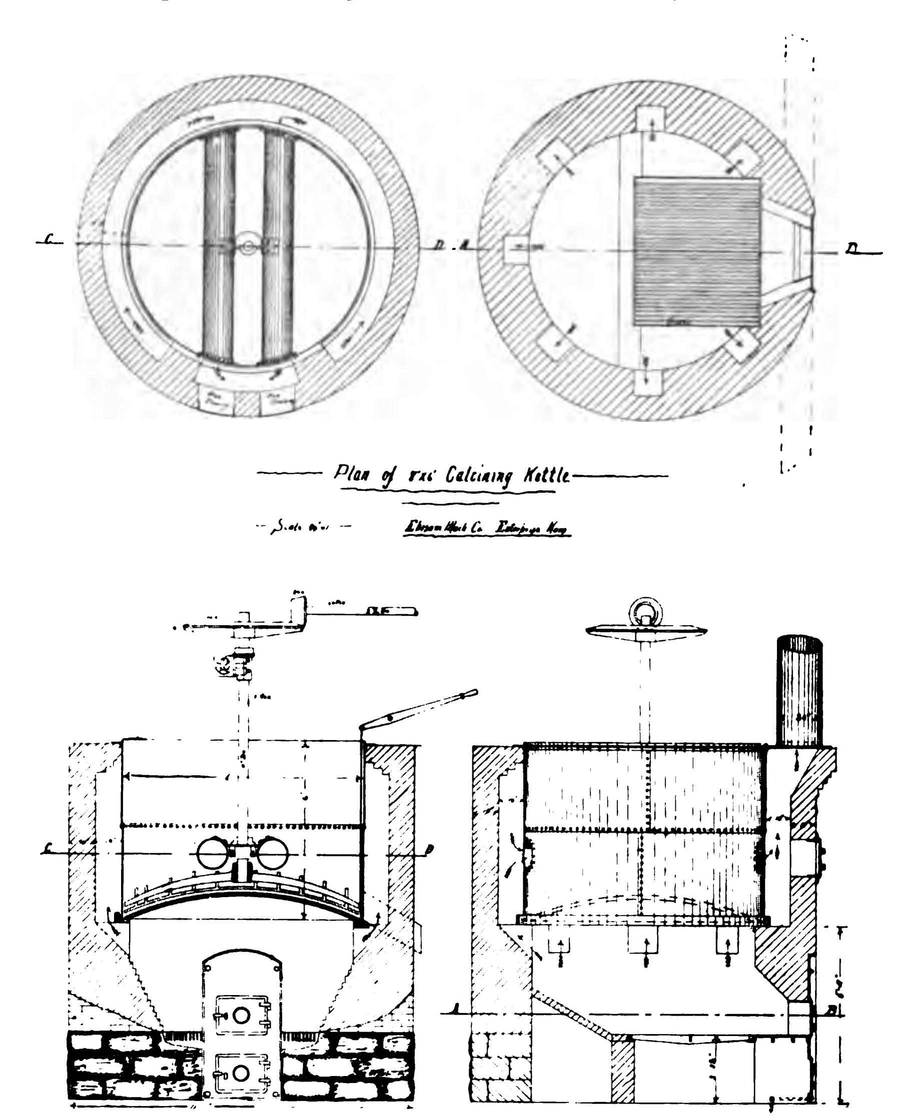


Figure 6. Gypsum Calcining Kettle.

The kettle is heated to about 240° F., before filling with the raw material, and this temperature is gradually increased to 340° F., as evaporation progresses. At the latter temperature the material stops the apparent boiling and *settles* down solid, leaving twelve to sixteen inches of vacant space at the top and the steam ceases to rise. After about one-half hour the material comes up again and then at a certain temperature, which is a trade secret, the whole mass is rapidly withdrawn through a gate near the kettle bottom and the plaster runs into a fire-proof bin on the ground. The kettle is then refilled, so that three kettles are usually burned in a day, and these require about 1400 pounds of coal.

During the process of calcination a *retarder* is mixed with the gypsum, the object of which is to form a plaster which will not set as quickly as the natural plaster of Paris. The latter sets in about ten minutes, while the retarder usually is added in sufficient amount to make it set in two hours, or in extreme cases in twenty-four hours. Various substances are used for this purpsse. Citric acid was formerly used with about two pounds to the ton of plaster, but the effect was apt to be very uneven. Magnesian limestone has been used with poor results. Sours and sweets form the worker's rule for retarders. Sorghum has been used with success; glue water was long in favor, but now they usually use patent retarders, known as Iola and Webster City retarders, and about fifteen pounds are used to the ton.

After the hot plaster passes from the kettle to the ground bin it remains about an hour to partially cool, and then it is raised to the second story and descends into a horizontal cylindrical reel, forty inches in diameter and ten feet long, slanting downward three-eighths of an inch to the foot. This is made of brass wire-cloth about forty by forty meshes to the inch. The tailings, usually about one per cent in amount, are carried back to the buhr mill and reground. The fine plaster is then run into 100 pound sacks or 250 pound barrels and is ready for shipment.

The advantages of wall plaster, made from gypsum, are outlined in the circulars of the various companies as follows: Being a perfect non-conductor of heat it is valuable for protection of iron joist, elevator shafts, and stairs; it sets and the walls dry out much quicker than lime work, so that carpenters can follow the plasterers almost immediately, as also the painters and paper hangers; any color can be mixed with the material in its preparation for mortar to produce any tint desired, and it does not affect coloring material as lime does; it requires less mortar than other materials; ceilings

and walls, thoroughly soaked from leaking and unprotected roofs, have not been in the least injured; it attains a high polish and is now largely used for wainscoting as a substitute for marble; this plaster makes walls fire-proof, and they are not affected by change of temperature, they do not chip or crack and they become harder with age; it is dense and hard and so vermin proof.

USES.

The gypsum of Kansas in its ground, uncalcined state, is used as land plaster for fertilizer, which is thought to be directly beneficial in its lime; but its main value is indirect in retaining moisture and ammonia which is slowly given up to the growing plants. In many states large portions of the gypsum is thus used, but in this state only 560 tons, out of nearly 65,000 tons in 1894, was ground into land plaster. In this condition it is also valuable as a disinfectant around houses and stables, through its absorptive properties taking up the offensive odors.

Most of the mineral is calcined, and then in its finer grades it is used for dental plaster and as plaster of Paris for casts and moulds and white finish for walls. It has been used with marked success for fire-proof material. For this last purpose the calcined gypsum is mixed with finely ground cinders and poured between the iron joists with temporary plates above and below, giving a smooth under surface for the finishing coat of the ceiling of the lower stories and a smooth upper surface on which the tile floor may be laid. This material is claimed to be thirty-five per cent lighter, twenty-five per cent greater strength, and sixty per cent cheaper than tiling, which has long been used for this purpose.

The greater portion of the calcined material, however, is manufactured into the form of cement or rock plaster, which is displacing in many portions of the country the ordinary lime plasters.

On the Chemical Composition of Some Kansas Gypsum Rocks.*

BY E. H. S. BAILEY AND W. M. WHITTEN.

(Preliminary Paper.)

The material used for these analyses was collected in the summer of 1896 by Mr. G. P. Grimsley. Great care was taken that the samples should be average samples, so that the analyses should represent the composition of the rock or dirt actually used at the mills. It is not necessary to give the details of the process of analysis, but it may be in order to state that special care was exercised, after the separation of the silica, that the calcium sulfate be fully dissolved by boiling, several times, if necessary, with dilute hydrochloric acid. The acid, if quite dilute, dissolved the sulfate very readily, but strong acid had little effect upon it. Water was determined by heating a sample in the air bath at 200° C. to constant weight. As a part of the water is driven off from gypsum at so low a temperature, it was deemed advisable to use the air dried samples for analysis.

The geological phases of this subject are more fully discussed by Mr. Grimsley. The occurrence of the rock, methods of manufacture, and the composition of the manufactured products, will be treated of in a later paper.

In Kansas there are at least three areas where the gypsum has been mined or quarried and used for commercial purposes. Other centers of the industry will, no doubt, soon be opened up. The three localities are, from the vicinity of Blue Rapids, the vicinity of Gypsum City, and the vicinity of Medicine Lodge. Analyses have been made of samples from two of these localities only. Those from the Gypsum City locality are from both Dickinson and Saline counties. It will be noticed that two kinds of material are used in manufacturing cement—the rock which is quarried and a soft, disintegrated material, which can readily be shoveled upon the cars. This is called "dirt," in the reports given below. It is

*An abstract of this paper was read before the Topeka meeting of the Kansas Academy of Science.

usually light brown in color and of such uniform texture that its true character would not be suspected. The results of the analyses are as follows:

Rock from Medicine Lodge mill, used by Best Brothers for the manufacture of cement.

	Per Cent
Silica and insoluble residue	.19
Iron and aluminum oxids	.10
Calcium oxid	32 53
Magnesium oxid	.16
Sulfuric anhydrid	45.73
Carbon dioxid (calculated)	.81
Water	20.46
Total	99.98

Calculating the above constituents as they probably exist in the rock, the result would be:

	Per Cent.
Silica and insoluble residue	.19
Iron and aluminum oxids	.10
Calcium sulfate	77.46
Calcium carbonate	1.43
Magnesium carbonate	.34
Water	20.46

The three following samples are from Hope: No. 1 is a sample from five cars at the entrance of Hope shaft; No. 2 is from a shaft west of Hope; and No. 3 is taken from boulders on a hill near Hope, and was formerly used at Hope mill.

	No. 1. Per Cent.	No. 2. Per Cent.	No. 3 Per Cent.
Silica and insoluble residue	.52	.34	.41
Iron and alumium oxids	.26	.16	.29
Calcium oxid	32.28	32.64	32.53
Magnesium oxid	.98	.62	.29
Sulfuric anhydrid	44.61	45.28	46.03
Carbon dioxid	1.90	1.42	.56
Water	19.47	19.63	19.70
Total	100.02	100.09	99.81

Calculating the above constituents as they probably exist in the rock, the result would be:

	No. 1. Per Cent.	No. 2. Per Cent.	No. 3. Per Cent.
Silica and insoluble residue	.52	.34	.41
Iron and aluminum oxids	.26	.16	.29
Calcium sulfate	75.84	76.98	78.25
Calcium carbonate	1.87	1.68	.55
Magnesium carbonate	2 06	1.30	.61
Water	19.47	19,63	19.70

Three samples from the vicinity of Dillon were analyzed. No. 1 is a sample of the dirt that is used at the Dillon mill. No. 2 is a sample of the dirt that is collected at a point about three miles south of Dillon. No. 3 is rock from a small quarry a little south of Dillon. It is not used at present.

	No. 1. Per Cent.	No. 2. Per Cent.	No. 3. Per Cent.
Silica and insoluble residue	12.13	17.10	.35
Iron and aluminum oxids	.99	2.04	.12
Calcium oxid	29.14	27.62	32.57
Magnesium oxid	.42	.59	.27
Sulfuric anhydrid	37.49	33.28	46.12
Carbon dioxid (calculated)	2.03	4.04	.57
Water	16.75	15.16	19.96
Total	98.95*	99.83	99.96

Calculating the above constituents as they probably exist in the rock, we have the following result:

	No. 1 Per Cent.	No. 2 Per Cent.	No. 3. Per Cent.
Silica and insoluble residue	12.13	17.10	.35
Iron and aluminum oxids	.99	2.04	.12
Calcium sulfate	64.63	56.58	78.40
Calcium carbonate	3.57	7.71	.56
Magnesium carbonate	.88	1.24	.57
Water	16.75	15.16	19.96

There are two samples from the vicinity of Solomon mills. No. 1 is a rock from the mine at the mill. No. 2 is the rock that occurs about a quarter of a mile east of Solomon mills. This material is used in small quantities mixed with the material from the mine at the mill.

	No. 1. Per Cent.	No. 2. Per Cent.
Silica and insoluble residue	.55	.38
Iron and aluminum oxids	.23	.16
Calcium oxid	32.64	32.04
Magnesium oxid	.22	.46
Sulfuric anhydrid	45.95	45.77
Carbon dioxid (calculated)	.63	.50
Water	19.54	20.37
Total	99.76	99.68

According to the above analysis the probable composition of the rocks is as follows:

*Alkalies undetermined.

	No. 1. Per Cent.	No. 2. Per Cent.
Silica and insoluble residue	.55	.38
Iron and aluminum oxids	.23	.16
Calcium sulfate	78.11	77.81
Calcium carbonate	.86	....
Magnesium carbonate	.47	.96
Water	19.54	20.37

One sample was analysed from the Tinkler farm. Tnis is also a dirt and was formerly used at Gypsum City. The analysis is as follows:

	Per Cent.
Silica and insoluble residue	4.54
Iron and aluminum oxids	.54
Calcium oxid	32.31
Magnesium oxid	.28
Sulfuric anhydrid	42 10
Carbon dioxid (calculated)	2.54
Water	17.82
Total	100.13

Calculating the above constituents as they probably exist in the rock, the result would be:

	Per Cent.
Silica and insoluble residue	4.54
Iron and aluminum oxids	.54
Calcium sulfate	71.57
Calcium carbonate	5.07
Magnesium carbonate	.59
Water	17.82

One sample was obtained from Rhoades, a point about seven miles south of Banner city. This was also of the variety known as "dirt." The analysis is as follows:

	Per Cent.
Silica and insoluble residue	3.06
Iron and aluminum oxids	.34
Calcium oxid	33.90
Magnesium oxid	.41
Sulfuric anhydrid	39.60
Carbon dioxid (calculated)	5.34
Water	17.24
Total	99.89*

*Alkalies undetermined.

Calculating the above constituents as they probably exist in nature the result would be:

	Per Cent.
Silica and insoluble residue	3.06
Iron and aluminum oxids	.34
Calcium sulfate	67.32
Calcium carbonate	11.03
Magnesium carbonate	.90
Water	17.24

Only one specimen of the gypsum was obtained from Clay county. This was from the mill at Longford, in the southwestern part of the county. The composition is as follows:

	Per Cent.
Silica and insoluble residue	18.69
Iron and aluminum oxids	1.21
Calcium oxid	26.71
Magnesium oxid	.43
Sulfuric anhydrid	33,27
Carbon dioxid (calculated)	3.15
Water	15.29
Total	98.75*

Calculating the above constituents as they probably exist in the rock, the result would be:

	Per Cent.
Silica and insoluble residue	18.69
Iron and aluminum oxids	1.21
Calcium sulfate	56.56
Calcium carbonate	6.10
Magnesium carbonate	.90
Water	15.29

It will be noticed by an inspection of the analyses that but one is given from Barber county, while seven are from Dickinson county, three from Saline county, and one only from Clay county. There has been great activity in Dickinson county, especially, in this industry for the past ten years.

But little need be said at this time in the discussion of the composition of these rocks. It has been noticed from the analyses above given and from a large number of other analyses of similar material made in the University laboratories, that the per cent of calcium sulfate is from sixty to eighty. The amount of water usually corresponds quite closely to the amount that theoretically

*Alkalies undetermined.

belongs to Gypsum. If the gypsum be pure the per cent of water approximates quite closely to 20.9 per cent, the theoretical amount. If on the other hand it contains large quantities of calcium carbonate or of silica and insoluble material; the per cent of water sometimes falls as low as 5.5.

Calcium carbonate is seldom found higher than twelve per cent, while it frequently, in the *rocks* especially, is less than one per cent. The magnesium salts are usually present, but in very small quantity, and, indeed, so small that their presence or influence could usually be ignored. It is difficult to decide just what part the silica plays in increasing the efficiency of the cementing material. It seems quite probable, however, that within certain limits the silica would tend to form silicates, after the manufactured material has been mixed with water and begins to "set." This problem, however, can be more satisfactorily discussed in connection with the process of manufacture and the composition of the commercial cements.

Restoration of Ornithostoma (Pteranodon).

BY S. W. WILLISTON.*

With Plate II.

In the Annals and Magazine of Natural History for January, 1871, Prof. H. G. Seeley proposed the name *Ornithostoma* for a genus of toothless Pterodactyls in the following words: "A new genus appears to be constituted by some three portions of the jaws from the Cambridge Greensand. Unfortunately the extremity is not preserved. They have the ordinary dagger-shaped snout, but appear to be entirely destitute of teeth. I provisionally name the genus *Ornithostoma*." It was not until 1876 that Marsh announced the discovery of the toothless character of the American Pterodactyls, giving them the name *Pteranodon*. Concerning this genus Seeley further says:† "There is, so far as I can discern, no evidence of generic difference between *Ornithostoma* and *Pteranodon*. There is perfect correspondence in the dagger-shaped form of the jaw, in the relations between the height of the jaw and the breadth of the palate, in the flattened sides of the snout, and their convergence superiorly into a rounded ridge, in the thin, rounded margin of the jaw which represents the alveolar margin, and in the smooth palate formed by a single, wide, concave channel." All this, and other evidence, Seeley obtained from the figures and descriptions given by Marsh.

In the article last cited Prof. Seeley figures the shoulder-girdle of *Ornithocheirus*, adding the statement, "I believe this form of shoulder-girdle is substantially the same in all the Cretaceous group." In this he is correct, so far as the genus *Pteranodon* is concerned. The very peculiar and remarkable structure of the scapula and coracoid is precisely that of the latter genus. In fact, every essential character that has been given so far for the European species of this group agrees quite with those of our Kansas specimens. This will demonstate how unimportant are the characters derived from the absence or presence of the teeth. Marsh

*For other papers on Ornithostoma by the writer see Kans. Univ. Quar., i, p 1; ii, p. 79; iv, pp. 61, 195,

†Ann. Mag. Nat. Hist., 1891, p. 440.

proposed a new order for these pterodactyls, baesd upon the absence of the téeth, but, as has been already shown for the orders of Ichthyosaurs and Birds based upon the same character, it is of subordinate value. Of course it is not yet certain that a perfect knowledge of the European species of *Ornithostoma* may not reveal generic characters to distinguish them from the American, but it is very doubtful, and the assumption that they are different, in the face of so much and direct evidence of identity, is unscientific. In Kansas rocks the genus is persistent in time, the species *O. ingens* reaching through nearly the whole thickness of the Niobrara rocks, and extending, as I believe, into the basal strata of the Ft. Pierre. I am confidently of the opinion that thorough examination of the Pierre deposits will reveal the genus throughout a large part of their extent.

From the study of the Kansas material in the University of Kansas Museum the following classification and characters seem to be most in accord with our present knowledge. I should prefer the term Pterodactyloidea for the suborder in place of Ornithocheiroidea. The character of the scapular union can not be of more than family value, since the resemblance otherwise between *Nyctodactylus* and *Ornithostoma* is too great to separate the forms into separate suborders.

Order Pterosauria.

SUBORDER ORNITHOCHEIROIDEA.—Tail short; wing metacarpal longer than the fore-arm; fifth toe rudimentary; nasal and ante-orbital vacuities more or less confluent.

FAMILY ORNITHOCHEIRIDÆ.—Distal end of scapula thickened and provided with articular facet for union with supraneural articulation. Carpal bones three in number.

SUBFAMILY ORNITHOCHEIRINÆ.—Jaws with well developed teeth.

SUBFAMILY ORNITHOSTOMATINÆ.—Jaws wholly edentulous.

FAMILY PTERODACTYLIDÆ.—Scapula thin on the upper end, not articulating with neural spine.

SUBFAMILY PTERODACTYLINÆ.—Jaws with teeth.

SUBFAMILY NYCTODACTYLINÆ.—Jaws wholly edentulous(?).

In the accompanying Plate II is given a restoration of *Ornithostoma ingens* Marsh. This species, of which *O. umbrosum* Cope is a synonym, is the most common one in the Kansas chalk. The characters which have been used to distinguish the species are, almost without exception, of doubtful value. The bones are invariably found crushed flat, with the articular surfaces distorted and changed.

For that reason I have yet failed to determine some of the species described previously. *O. ingens* is, however, more easily recognizable from the size alone, in which it seems very constant. Among the material of this genus in the University I have recognized four species, based partly upon size, partly upon structural differences. Such differences are found in the shape of the humerus, the terminal wing phalanx, the relative length of the bones, etc.

The material which I have referred to *O. ingens* includes some twenty specimens, which have furnished all parts of the skeleton save some of the cervical and dorsal vertebræ, the pelvis and the larger part of the skull. The pectoral girdle and anterior extremity, with the exception of the terminal phalanx, together with the complete leg, are from one specimen—the vertebræ from another. The pelvis is drawn from a specimen of another species, comprising the larger part of the skeleton. The resemblances of the skeleton throughout are so great that there can be little doubt that the pelvis would be equally indistinguishable, save by size. It is unnecessary to add that its size in the drawing has been made proportional to that of the other bones. Of the skull, the larger part of the lower jaws and some of the posterior portions are alone available in this species, and the remainder is taken from one belonging to a smaller form. I have assumed that this latter specimen is of another species, but the difference in size is all that I have so far been able to discover.

The number of dorsal vertebræ can not be determined. The relative positions of the pectoral girdle and leg in several specimens show pretty conclusively that the trunk could not have been longer than has been figured.

Altogether the skeleton of *Ornithostoma* presents some very remarkable characters. I believe there is no other reptile in which prosthenic features are carried to as high a degree as in this. The disproportion between the fore and hind extremities is almost ludicrous. The pelvis is exceedingly small, the legs not only small but weak in all respects. That the animal could have stood upon its feet free on the ground I do not believe possible. The neck vertebræ are relatively stout, but the neck was not remarkably elongated, to carry such a head as the animal possessed. Furthermore the remarkable mode of articulation of the neck and anterior dorsal vertebræ seems to indicate a restricted range of torsion, though tolerably wide sagittal flexion. The occurrence of the remains of the large species in strata evidently formed remote from

the shore lines, as shown by the entire absence of other shore animals, turtles, etc., indicate great powers of flight. Furthermore, it is rare that a single bone of a pterodactyl is found unassociated with others, and almost invariably the bones of the wings are found more or less in connection indicating either tough and strong tendons, or a rapid sinking of the skeleton, which might happen from the rapid filling of the hollow bones with water through their pneumatic openings.

Notwithstanding the enormous expanse of the wings, these animals when alive must have weighed but little. I doubt very much if one of the largest species reached twenty pounds. When at rest, the phalanges of the wings were doubtless folded almost parallel with the metacarpal, as they are sometimes found preserved in this position. There was very little movement in the wrist, considerable in the elbow, and very much in the shoulder. In the humerus there is a remarkable projection for muscular attachment corresponding to the deltoid tubercle, but I doubt very much that it was for the exclusive insertion of muscles corresponding to the deltoid, inasmuch as its large and strong face for muscular attachments points away from the shoulder and towards the arm. On the inner mesial side there is also a strong projection proximally, which I doubt not was for the pectoral muscles, muscles which must necessarily have been most important in keeping the wings outspread. The imperfect or rudimentary claws and the weak toes mean that the animal could not have used the feet effectively for grasping, while the exceedingly free movement of the femur in the actetabulum must indicate great freedom of movement of the hind legs and corresponding lack of strength. Altogether, I believe that the function of the legs was chiefly for guidance in flight, through their control over the membranes. I suspect that the membrane from the wings extended a considerable distance upon the sides of the legs, and, perhaps, connected them in part. From the comparative heaviness of the head and vertebræ, and the structure of the latter, it is also probable that in flight the neck was curved backward in its lower part. If the animal hung in the upright position when at rest, it is difficult to see where the head was stowed away.

The length of this species from tip of outstreched bill to tip of toes was about eight feet, the expanse of the wings in the posture shown in the engraving was eighteen feet and six inches. It is often erroneously stated in text-books that the distance between the tips of the wings in this species was twenty-five feet.

Skull.

The shape and structure of the skull I have described in previous papers. In the present species the total length of this part of the skeleton was considerably less than four feet. A most careful examination of the alveolar borders of both maxillæ and mandibles, has revealed no indications of teeth, even rudimentary ones. The position of the occipital condyle is such that the head might have been flexed to an acute angle upon the neck. In the figure here given the width of the head is less than has been heretofore figured, but it is certainly more nearly correct.

Vertebræ.

The number of cervical vertebræ is seven, and, in all probability, not more. The atlas and axis I have never seen. It is probable that they do not differ materially from the bones of *Nyctodactylus*, as already described by me in a previous paper. The third cervical is the longest, the others successively decreasing in length. The first and second dorsal are short, and bear well developed, double-headed ribs. The difference between the last cervical and first dorsal is considerable. The third, fourth and fifth dorsals, if my determination is correct, have the centra and ribs co-ossified for the support of the scapula. The succeeding vertebræ are short, cylindrical bones, with a hemispherical ball, and with elongated transverse processes situated high upon the arch. The number is indefinite.

Fourth cervical vertebra.

The centrum is elongated. The ball is much broader than high, and strongly convex in both directions; its upper border is convex, but the inferior margin is emarginate on each side. On each side there is a stout process, jutting downwards and backwards from the side of the centrum on each side, having on the posterior surface a concave articular facet, oval in shape and touching or slightly separated from the articular surface of the ball. The facet looks downwards, backwards, and outwards. The under side of the centrum, between the two processes, is concave. The corresponding articular facets on the anterior end of the centrum are somewhat smaller, are convex and distinctly separated from the concavity of the centrum. The articulation of the centra with each other thus depends upon three distinct, or nearly distinct surfaces, the lateral inferior ones convex on the cup end, concave on the ball end. Such a mode of articulation would seem to limit the motion to one in a vertical, antero-posterior plane, while greatly strengthening

the joints. I know of no similar arrangement in any other vertebrate animal, and will, for convenience, call the articulations exapophyses. The anterior zygapophyses project distinctly beyond the plane of the cup and are widely separated from each other. From the tip of the processes a ridge runs downward and inward to the outer part of the pre-exapophyses. The post-zygapophyses are concave and oblique. Above them there is a stout metapophysis. The spine is elongate and thin, and apparently only a ridge.

The third cervical is somewhat longer and has a distinct tubercular hypopophysis on the anterior end, near the margin of the cup. The sixth and seventh are shorter, and the spine is directed more backwardly and is a little longer.

First dorsal vertebra.

The centrum is short and broad, so different from the preceding vertebræ that it is possible there is an intervening one omitted. The ball is more than four times as broad as high, concave on the upper side, convex below. The post-exapophyses are large and confluent with the articular surface of the ball, but are concave. The convex pre-exapophyses, at the outer sides of the cup, are at the base of the lower root of the elongated transverse process.

The ventral surface of the centrum is flattened transversely. Near the margin of the cup there is a small, but prominent, bifid tubercle, projecting cephalad and ventrad. The transverse process is elongate, and compressed cephalo-caudad. It is incomplete, but, if of the same structure as in *Nyctodactylus*, it bears both articular facets for the rib. Its lower root arises from the sides of the centrum, having at its base the pre-exapophysis. The upper root arises from the sides of the pre-zygapophyses. The latter are oval in shape, with the faces looking upward and inward; they are remote from each other. The spine is broad and short, with its upper extremity bifid and thickened. The neural canal is of large size.

An imperfect vertebra, evidently following the one described above, has the centrum very similar, save that it is broader and shorter, and the hypopophysis is hardly perceptible. The transverse processes are broken off. The zygapophyses are stouter, but more approximated, and the spine appears to be less stout.

The next three succeeding vertebræ are evidently those co-ossified to support the scapula. The centra are firmly co-ossified, showing only a ridge between them. The cup anteriorly has the exapophyses laterally, from which arise the stout inferior root of the transverse processes. The upper root, which is broader, arises as in the preceding, its anterior border continuous with the zygapophy-

ses. The process is very broad, elongated and stout, and evidently represents the co-ossified rib. There is a round foramen between the two roots. It is probable that each of the vertebræ has a similar co-ossified rib on each side, but only that of the anterior one is preserved.

In another specimen, the co-ossified neural spines, or, as I believe them to be, the ossified supraspinous ligaments or cartilages are united to form a stout vertical plate of bone, which bears on each side an oval articular facet for union with the end of the scapula.

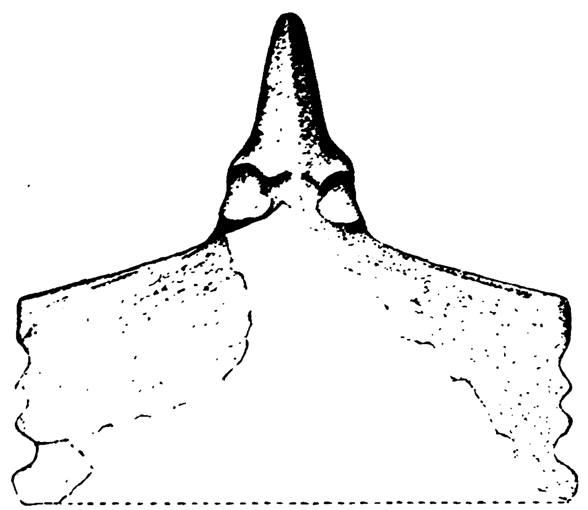
Measurements of cervical vertebræ, Ornithostoma sp. (No. 2211).

Length of centrum, third cervical	48 mm.
Length of centrum, fourth cervical	44
Width of ball	16
Height of ball in middle	8
Distance between pre-exapophyses	16
Diameter of pre-exapophyses	6
Diameter of neural canal	7
Length of centrum, fifth cervical	42
Width of post-exapophyses	28
Length of centrum, sixth cervical	36
Length of centrum, seventh cervical	30
Width of ball	18
Length of centrum, first dorsal	13
Width of ball	20
Distance between anterior zygapophyses	14
Transverse diameter of neural canal	9
Width of neural spine at base	14
Height of vertebra, approximated	41
Length of centrum, second dorsal	12
Width of ball	25
Diameter of neural canal	10
Length of centrum, third dorsal	16
Width of cup, including lateral facets	25
Length of centrum, fourth dorsal	15
Length of transverse processes preserved, from prezygapophyses	64
Width of same	16

Ornithostoma ingens (No. 1951).

Length of centrum, fifth cervical	66 mm.
Width of ball	28
Height of ball in middle	12

Distance between pre-exapophyses .... 28 mm.
Diameter of pre-exapophyses 10
Diameter of pre-zygapophyses 12
Distance between pre-zygapophyses 22
First dorsal vertebra, length of centrum 25
Transverse diameter of ball 33
Second dorsal vertebra, length of centrum 30
Width of ball 25
Diameter of neural canal 12
Length of co-ossified transverse process and rib of third dorsal vertebra from anterior zygapophysis, as preserved 130
Diameter of same at distal extremity 10
Diameter of same near pre-zygapophysis 15


Sternum of *Ornithostoma species*, one half natural size.

Sternum.

The sternum is not preserved in any of the specimens of *O. ingens* in the museum, but is represented in a skeleton of a closely allied, smaller species. It is extremely thin and pentagonal in outline. Projecting in front of the articulations for the coracoids is a stout process, obtusely pointed, and evidently directed somewhat ventrally in life. The articular facets look dorsad and laterad and are gently convex from side to side and concave antero-posteriorly. Just back of the articulations the moderately thickened borders slope obliquely backward to the full width of the bone. The first articular facet for the ribs begins at the angles and runs backward

a half inch. It is of considerable thickness, and may be for the attachment of the stout co-ossified rib attached to the first of the consolidated dorsal vertebræ. The lateral margins of the sternum, back of the angle, are thin, and have three emarginations, separating four articular projections. The three posterior ones are small and pointed, and could have given attachment to only slender ribs. The lateral borders are parallel with the longitudinal axis of the bone. The posterior border is not preserved, but from the general resemblance to the bone in *Nyctodactylus*, I believe that it is nearly straight, although it may have been gently concave or convex. The bone was in all probability concave above in life.

Length of presternal projection in front of articulations	44 mm.
Diameters of coracoid articulation	12, 14
Width of bone	140
Length of bone	120
Length of lateral margins	55
Length of anterior oblique margins from coracoid articulation	55

Coraco-scapula.

This bone is stout, U-shaped, with the coracoid arm distinctly longer than the scapular. The distal extremity of the scapula has a large oval facet placed obliquely to the long axis, and evidently also obliquely to the transverse axis of the body, indicating that the bone was directed not only outward and downward, but also more or less forward. The shaft in all the known specimens below the articulation is trihedral or flattened, but in life it was evidently round or oval in cross-section. On the lower part the width is greater, due to a projection of the dorsal side before the glenoid articulation, for the attachment of muscles. The glenoid articulation is deeply concave from above downward, convex from side to side and bounded both above and below by a prominent ridge, that on the inferior border being much stronger than the upper one. The surface is markedly oblique to the plane of the bone, doubtless in life directed outwardly and posteriorly in the oblique position of the bone that I have described. The surface is considerably narrower from side to side below than above, and in this direction it is convex throughout. A rugose line, indicating the junction of the two bones, passes directly backward near the middle of the articular surface. At the bottom of the U, formed by the conjoined bone, there is a process arising from the scapula and reaching to the anterior surface of the coracoid, to which it is joined; it in-

closes a small, oval foramen just back of the middle of the glenoid surface. The diameter of the foramen is about twelve millimeters.

The shaft of the coracoid is flattened antero-posteriorly in all the specimens, though probably in life oval. On its proximal half there is a prominent process on the inferior border for muscular attachment. From beyond the middle the sides of the bone are parallel. The sternal articulation is gently concave in one direction and slightly convex in the other, to agree with that of the sternum, forming a reciprocal joint, which must have had considerable mobility. A little above the sternal end, on the posterior side, there is a narrow rugosity, more than an inch in length, for muscular attachment.

The side to which a given bone belongs may be determined by holding the bone with the sternal end toward one and the glenoid articular surface looking obliquely upward; the scapular end will then be directed to its proper side.

The bones have a close resemblance to those figured by Seeley in *Ornithocheirus* (Ann. Mag. Nat. Hist., 1891, 441.) The vertebra and sternum in this figure are, however, undoubtedly wrong. The ball of the centrum in this region does not have so much of the horseshoe shape, but is transverse, and undoubtedly the ribs are here stout and anchylosed to the centrum.

Length of coracoid to glenoid margin	181 mm.
Diameter sternal articulation	25
Width of shaft distally	30
Length of glenoid surface	50
Width of same	30
Length of scapula from glenoid margin	160
Distance between scapular and sternal articulations	170
Greatest diameter suprascapular articular surface	25

Humerus.

The humerus is the stoutest bone of the body. Its proximal articulation, for union with the glenoid, is concave from side to side, convex in the other direction, with its width much greater on the ulnar side. Beginning at the head, the radial border slopes outwardly with a gentle concavity, into a broad, rounded process. This process, the radial or deltoid, has its convex, rounded extremity directed obliquely forward and upward or outward; the broad surface for muscular attachment, about two inches in length and one in breadth, is directed almost opposite to that of the glenoid

articulation. It is hardly possible that the process gives attachment to any shoulder muscle; certainly its chief use can not be for a deltoid muscle, and the name deltoid as applied to it is, I believe, improper. Below the process the bone suddenly narrows to its least width, which is distinctly above the middle. From this contracted place the bone again widens gradually to the extremity. The ulnar border of the bone is nearly straight throughout.

On the anterior ulnar side, immediately beyond the head, there is a large process, directed inferiorly and anteriorly, which is doubtless for the attachment of pectoral muscles, and may be known as the pectoral process. It does not extend so far as does the radial process, and is not so large; usually it is crushed flat to the shaft of the bone.

At the distal extremity there is a large, oval, articular surface on the radial side, inclined anteriorly, for articulation with the radius. Back of this there are two articular surfaces, separated by a pit or depression. The anterior one, the smaller one, is seen from the anterior side, while the posterior is on the posterior side, concealed by a process at the distal extremity of the humerus, which is strongly convex on the inferior margin, straight on the distal.

Length of humerus, ulnar side	285 mm.
Greatest diameter proximal articular surface	50
Greatest transverse diameter of same surface	30
Width of bone 110 mm. below upper extremity	39
Greatest width through radial process	100
Width of distal extremity	80

Ulna.

The ulna is the larger bone of the forearm. At the proximal end there are two concave articular surfaces, meeting each other in an angle, which is lodged in an excavation in the humerus. In life the ulna overlapped the radius to some extent when seen from in front. The bone is narrowed at the middle, expanding distally, more especially on the radial side. The distal extremity has two articular facets, of which the lower one is the larger. On its radial border the margin is expanded for about an inch and a half above the articulation, and is roughened. Near the distal end, between the two articular facets, there is a large pneumatic foramen.

	1951.	2217.	1960.
Length	374	385	380 mm.
Width proximally	60	60	62
Width distal extremity	83	81	77
Width in middle	45	48	45

Radius.

The radius is a much more slender bone than the ulna, its extremities not as much dilated. In a specimen compressed laterally the proximal end shows a deep pully-like articulation, divided by a ridge in the middle. At the distal extremity it is more expanded than proximally, with a single articular facet, and an expanded, non-articular radial margin.

	1951.	2217.
Length	370	380 mm.
Width proximal extremity	45	43
Width distal extremity	51	
Width of shaft	24	29

Carpus.

The carpus has three bones. By reason of the constant compression and distortion to which they are subjected, it is difficult to recognizably describe them. The proximal bone is the largest, and has two facets on the proximal surface for articulation with radius and ulna. The lateral carpal, the smallest, is sub-triangular or sub-quadrangular in shape, with an oval or rounded facet on the proximal end, and another, smaller, near the distal end, forming an emargination on the border. A good figure of this bone is given by Cope. Cret. Vert., p. vii, fig. 3. "Professor Marsh finds the carpus to have the same structure in the toothless Ornithosaurs from Kansas (as in Ornithocheirus) and discussed it fully in April, 1882 (Am. Jour. Sci.), though without mentioning memoirs in which the structure has been figured, and from which the interpretation appears to have been taken."*

Measurements:

Greatest diameter of proximal carpal, as compressed..75 mm.
Greatest diameter of lateral carpal..................35

Metacarpals.

The first metacarpal or Pteroid, has a proximal expansion and articular surface, for union apparently with the distal articular surface of the lateral carpal. It terminates in a free, pointed distal end. One or two small ossicles, oval in shape, are found with the carpal bones. They are probably sesamoid bones. The three following metacarpals are slender splint bones about one-third of the length of the wing metacarpal. Professor Marsh has described the second as being thread-like proximally. They all terminate in an expanded end, which is curved outward and has a rounded articular surface for the phalanges. The phalanges

*Seeley, Ann. Mag. Nat. Hist., April, 1891.

of these fingers are of two kinds. The proximal ones are elongate, with a contracted shaft, about an inch and a quarter in length, with the proximal end concave and the distal convex with a median depression. The others are but little longer than broad, with similar articular surfaces. The ungual phalanges are broad, and strongly curved, terminating in a sharp point, and much resembling the claws of carnivores. The proximal end has the articular surface on the upper half only.

The fifth metacarpal is much broader at the base, gradually diminishing in size to near the distal extremity, where the bone must have been subcylindrical in section with the under surface flattened or grooved. Proximally the bone appears to have had a gentle convexity on the proximal end and a corresponding concavity on the under side. The articular surface for the carpal is large, with the dorsal border somewhat produced for muscular insertion. The distal extremity is placed somewhat obliquely to the shaft, being directed downward and forwards. The articulation is a very complete pulley-shaped mass, permitting motion through nearly half a circle. The posterior condyle extends through more than three-fifths of a circle, with its lower border directed forward and projecting beyond the anterior surface of the shaft, permitting the corresponding articulation of the first phalange to overlap the shaft to a considerable extent. The anterior condyle extends through a lesser arc and does not project beyond the surface of the bone, the corresponding articulation of the phalange being shorter. The articular surface is deeply grooved, the groove being before the middle, the broader surface belonging to the posterior condyle. The inferior surface of the shaft distally is concave, and behind the proximal ends of the articular surfaces there is a pneumatic foramen.

Measurements of wing metacarpal:

Length	580	590	594	615 mm.
Width at proximal end	78	70	70	70
Diameter of shaft before condyle	32	30	28	32
Diameter of anterior condyle	36	35	34	40

First Phalange.

The first phalange of the wing-finger is the longest bone in the body. On the proximal end the shaft is expanded, but beyond the proximal fifth the sides of the bone are nearly parallel and straight to near the tip, where the whole bone is bent downward. The proximal articular surface is deeply concave in outline, the chord

of the concavity being at about 45° to the shaft of the bone. The two articular surfaces are gently concave and oblique, the posterior elongate oval in shape and extending to the inferior produced portion of the bone, which overlaps the inferior part of the shaft of the metacarpal when fully flexed. The anterior articular surface is narrower and situated more dorsally. The two surfaces are placed obliquely on the shaft, corresponding to the obliquity of the head of the metacarpal. The upper border of the bone has a prominent tuberosity on the beak, separated by an oblique notch from the thickened upper border of the bone. The notch is doubtless for the insertion of muscles. The distal end of the bone is curved downwards, the inferior border of the articulation reaching about a half an inch below the lower border of the shaft. The articulation is at right angles to the shaft of the bone with the upper angle broadly rounded. Doubtless in life the surface was oval in shape and like the two following bones.

Measurements:

Length	580	590	590 mm.
Breadth at proximal extremity	67	65	65
Breadth of shaft	30	27	24
Diameter anterior condyle	35	35	34

A partial description of the pelvis and leg has been given in a previous paper in this journal,* to which the reader is referred.

Second-fourth wing phalanges.

The second and third wing phalanges can not be distinguished from each other, save by size; nor can the side to which they belong be determined in the crushed specimens. They are most dilated on the proximal end, the sides narrowing to near the proximal third of the bone, whence they are nearly parallel or gently divergent to near the distal extremity. The proximal articular surface is concave and transverse to the long axis of the bone. This surface reaches quite to the inferior border of the bone, which is here curved downward. The upper border, for a short distance, is flattened and convex, with a roughened surface on the proximal end for muscular and ligamentous attachments. The terminal phalanx is curved throughout, ending in a free styloid extremity. In some of the smaller species this bone is straight.

	1951	2205
Length second phalange	500	485 mm.
Width proximal end	53	46
Width distal end	30	30
Width of shaft	22	20
Length third phalange	330	
Width proximal end	32	
Width of distal end	18	
Width of shaft	13	
Length fourth phalange (chord)		170
Width proximal end		20

*Kan. Univ. Quar., II. 79.

Femur.

The head of the femur is nearly hemispherical, supported upon a cylindrical neck, placed at only a slight angle with the long axis of the bone. The trochanter is low and obtuse, situated at the top of the long axis of the shaft. The shaft is of nearly equal width throughout, with a strong anterior curvature. From a little below the trochanter, the outer border of the shaft is markedly concave, the inner correspondingly convex. The distal articulation is broad, with two, shallow, trochlear grooves, separated by a median convexity or ridge. It permits only a moderate amount of flexion with the tibia, less than 45° from a straight line. In the popliteal depression there is a small pneumatic opening.

Tibia.

The tibia is a slender bone, gradually decreasing in width from the proximal end to near the distal articulation; the front border is straight, the posterior gently concave. The proximal articular surface is at right angles to the long axis of the bone, and is broadest transversely on the posterior part. On the outer surface, about fifty mm. below the end of the bone, is a roughened tubercle about one half inch in length, for muscular attachment. The distal extremity, representing, I suppose, the co-ossified proximal row of the tarsus, forms a pulley-like mass, the articulation extending through nearly three-fourths of a circle, moderately deeply grooved in the middle. On the inner side, just above the articular border anteriorly, there is a well-marked tubercle for ligamentous or muscular attachment.

Tarsus.

There are but two tarsal bones, irregular in shape and flattened. They lie side by side, and are not at all superimposed. Their greatest and least diameters are respectively, 20 and 6, and 20 and 7 millimeters.

Leg of *Ornithostoma ingens*, one-fifth natural size.

Foot.

The first four metatarsals are very slender, straight and contiguous with each other, each having a flattened proximal articular surface and a rounded trochlear distal extremity. The metacarpal of the fifth toe is rudimentary, sub-triangular in shape, with the obtusely pointed distal part curved, altogether resembling an obtuse claw.

The first toe has a single phalange, which is long, cylindrical, gently curved and obtusely pointed.

The second toe has two phalanges, the first of which is elongate and grooved with a distal trochlear articulation. The second resembles that of the first toe, but is shorter.

The third toe has four phalanges, the proximal one of which is like that of the second toe, but is elongate; the second is broader than long; the third is like the first, but shorter; the fourth is a short, scarcely curved and obtusely pointed claw.

The fourth toe has five phalanges, of which the first, fourth and fifth resemble the first, third and fourth of the third toe, the second and third the second of the same toe.

The fifth toe has no phalanges.

Measurements of leg bones.

Femur, length	260 mm.
Femur, diameter of head	20
Femur, diameter of neck	12
Femur, width of condyles below	30
Femur, width of shaft	25
Tibia, length	362
Tibia, diameter of proximal end	34
Tibia, diameter of shaft at middle	19
Tibia, diameter of shaft above trochlea	16
Tibia, greatest diameter outer condyle of trochlea	20
Metacarpal, length of first	101
Metacarpal, length of second	105
Metacarpal, length of third	95
Metacarpal, length of fourth	80
Metacarpal, length of fifth	25
Metacarpal, width of same at base	15
Phalanges, first digit, length of proximal	41
Phalanges, second digit, length of proximal	25
Phalanges, " " length of second	31
Phalanges, third digit, length of proximal	35

Phalanges, third digit, length of second	4 mm.
Phalanges, " " length of third	27
Phalanges, " " length of fourth	12
Phalanges, fourth digit, length of proximal	40
Phalanges, " " length of second	3
Phalanges, " " length of third	3
Phalanges, " " length of fourth	26
Phalanges, " " length of fifth	12

Summary of Characters, Ornithostoma.

Head much elongated, the jaws slender, pointed and wholly wanting in teeth. External nares and ante-orbital vacuities united; supratemporal fossa of large size; occipital crest elongated. Neck elongated, non-costiferous, with exapophysial articulations, and rudimentary spines. Three anterior dorsal vertebræ co-ossified and bearing a supraneural plate for articulation with scapula. Posterior dorsal vertebræ decreasing in size, procoelous, the trensverse processes situated high up. Sacrum composed of six or seven vertebræ, the anterior ones with long transverse processes, the posterior three sessile. Tail short, small, the vertebræ without transverse precesses and amphiplatyan. Anterior ribs strong, double headed, those of the co-ossified vertebræ anchyloned to vertebra. Posterior ribs weak, single headed; adbominal ribs present. Coracoid and scapula united, the latter articulating with supra-neural facet, the latter with the sternum; a scapular foramen present. Sternum pentagonal in outline, with stout anterior projection; the sides with four costal articulations. Ilium with an elongated anterior projection; pubes free, band-like, co-ossified, with anterior articular projection, the bone attached to tuberosities on the anterior border of the ischia. Ischia broad, uniting in a symphysis posteriorly, with "thyroid" foramen, below acetabulum. Bones of the forearm longer than the humerus, and shorter than wing metacarpal. Carpus composed of three bones, in two rows; median phalanges of second, third and fourth fingers short; four phalanges in the patagium, the terminal one curved or straight. Femur curved, trochanter small; tibia longer than the femur, with trochlear articulation below; fibula wholly wanting; tarsus with two bones only, in a single row; four functional toes, elongate, slender, the fifth consisting of a rudimentary metatarsal; middle phalanges of third and fourth toes very short; first and second without true claws.

Notice of Some Vertebrate Remains from the Kansas Permian.

BY S. W. WILLISTON.

Some months ago numerous fragments of bones, obtained from an excavation of a well in Cowley county, were sent me for examination by Mr. C. N. Gould. The horizon whence the bones came is clearly lower Permian, not far from its base, as accepted by Professor Prosser, the recognized authority on the Kansas Permian stratigraphy.

Not knowing whether additional material will be obtainable I give here a description of some of these bones, which will be more fully illustrated in the future, should no better specimens be secured.

An intercentrum clearly belongs to the genus *Cricotus*, and is closely allied to the typical species described by Cope from the Permian of Illinois.* His description applies so well to the specimen in hand that I use his language, amended:

"The caudal intercentrum best preserved is short, discoidal in form and deeper than wide. The articular faces are deeply concave, the posterior more strongly so, and the middle is occupied by a foramen, whose diameter is about equal to one-half that of the intercentrum on either side. The lateral borders of the posterior articular face are less rounded than the anterior ones. The chevrons are slender and directed very obliquely backward, their bases are firmly co-ossified with the intercentrum. On the superior surface two shallow pits occupy considerable space. They are separated by an obtuse ridge, and are bordered by a raised ridge from the polished layer of the lateral surface."

"Several phalanges of short, wide proportions show much resemblance to those of certain dinosaurs."

Diameter of intercentum, vertical	18 mm.
Diameter of intercentrum, transverse	17
Diameter of intercentrum, longitudinal	11

*Proc, Phil. Acad. Nat. Sci. 1875, p. 405.

Proximal width of phalanges	12	12	13 mm.
Proximal depth of phalanges	8	7	6
Length of phalanges	14	15	11



Fig. 1. Fragment of jaw of *Cricotus* sp enlarged two diameters.





Fig. 2. Phalange. Fig. 3. Tooth of Cricotus. Both enlarged

Another vertebra, of smaller size, doubtless represents a true centrum (see Cope. Trans. Amer. Phil. Soc., xvi, p. 245). It differs very materially in having remote satural surfaces for the attachment of the neural arches, in being somewhat cordate in shape and in showing no surfaces for articulation of the chevrons. The ends are concave as in the intercentrum, and the notochordal foramen is of the same relative size. The anterior lips of the cup are more beveled than the posterior ones. The outer surface is concave longitudinally with an obtuse keel below. The posterior sutural surface for the arch is much larger than the anterior. There are no longitudinal ridges on the sides of the centrum, as shown in the figures of *C. crassidiscus* Cope (labeled C. *heteroclitus* by Zittel). The floor of the neural canal is flat.

Transverse diameter of centrum	15 mm.
Vertical diameter of centrum	13
Length of centrum	7
Width of neural surface	5

Numerous portions of sculptured scutes and plates and a fragment of a jaw with one complete tooth I doubt not belong with the vertebræ. The outer side of the jaw fragments is shown in the accompanying photographic illustration, together with the tooth and a phalange; they are all enlarged. From a microscopic section of the base of the tooth I have made, with the aid of a camera lucida, the accompanying drawing. It would be of interest to know how nearly the figure resembles that of the other known species.

None of the characters are sufficient to distinguish the species from the other described ones, especially C. *heteroclitus* Cope.

A single dorsal vertebra, and, perhaps, some phalanges, belong clearly in the genus *Clepsydrops* Cope, also originally described

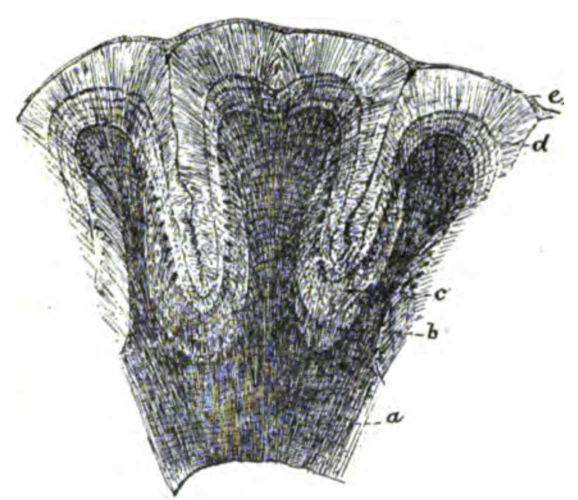


Fig. 4. Section of tooth, *Cricotus*.

from Illinois, and are closely allied to the typical species. In its description I follow Cope's language in the paper first cited for a dorsal centrum: "It is deeply bi-concave, the articular cavities being funnel-shaped and continuous, thus perforating the entire length of the centrum. * * The cavities communicate by a very small orifice. In an anterior dorsal the anterior cavity is as widely excavated at the border as the posterior funnel. Another peculiarity is the absence of processes of the centrum, and a small capitular articulation is seen sessile on the border of the cup of two of the dorsals. The dorsal vertebræ have their sides somewhat contracted; in one specimen the inferior face is longitudinally acute. In this dorsal the floor of the neural canal is interrupted by a deep fissure; which has a triangular shape with the apex downward, when seen in profile. The diapophysis does not project far beyond the base of the neural arch." It is sessile with an elongated cupped articular surface.

The phalanges are of more slender form than those of *Cricotus* The shaft is depressed and the distal condyle is not emarginate.

Length of centrum	15	14 mm.
Depth behind	14	12
Width behind	14	12
Length of phalange	13	
Depth proximally	5	
Width proximally	8	

As will be seen, the centrum, while nearly the same size as that measured by Cope of *C. collettii* (second column), are of somewhat different proportions, but not sufficiently so to justify specific separation.

Associated with these remains are numerous teeth and spines of *Pleuracanthus* (*Didymodus ?*) and plates of a ganoid fish.

Altogether we have here an interesting series of forms, so closely resembling the species described by Cope from Dansville, Illinois. that I cannot distinguish them specifically. It would seem to demonstrate the contemporaneity of the two formations, as also that of the Texas Permian, whence species of all these genera have been described by Cope.

Above the stratum in which these bones are found are several hundred feet of limestone and shales, above which come the red beds of Clark and Comanche counties, which have been variously referred to the Permian and Trias. That this basal Permian fauna continued throughout all the time represented by eight hundred or a thousand feet of deposits does not seem probable to me, and I believe yet more strongly, what I always have believed, that the red beds of Kansas are Triassic in age. If they be Triassic, and corresponding to the red outcrops of the foot-hills in Colorado, it would seem strange that the intervening deposits between them and the Dakota, in the regions separated by only a few hundred miles, and agreeing in many lithological characters, should be in one case Cretaceous and in the other Jurassic.

A New Plesiosaur from the Kansas Comanche Cretaceous.

— —

BY S. W. WILLISTON.

Plesiosaurus Gouldii n. sp.

Several nearly complete dorsal vertebræ from the Comanche shales of Clark county, Kansas, represent a hitherto undescribed species of a Plesiosaurid, differing very distinctly from P. Mudgii Cragin in its much larger size and the shape of the centrum. It is probable that the cervical vertebra described and figured by me in this journal, vol. iii, p. 2, belongs with the same or a closely allied species.

The dorsal vertebræ are markedly characterized by the peculiarly cordate form of the centrum. The anterior face is rather deeply concave, for this part of the column; clearly cordate in outline, with a small emargination above. The anterior zygapophyses are spout-like, the notch between them not extending further than the middle of the articular surfaces. The spine is short and small. The transverse processes are compressed, springing in part from the centrum, in part from the base of the pedicles. The body is compressed in the middle, forming an obtusely rounded surface below. About midway on the sides, below the lower root of the transverse process, the side is pinched in, with a small vascular foramen at the bottom of the depression.

Width of anterior end of centrum	110 mm
Vertical diameter, same end	75
Length of centrum	79
Height of centrum	175
Expanse of diapophyses	175
Width of neural canal	30
Expanse of anterior zygapophyses	50

Table for the Calculation of Analyses.

BY EDWARD BARTOW AND JOHN NAVARRE MACOMB, JR.

This table was compiled for use in the chemical laboratory of the University of Kansas, using the atomic weights taken from, "A Recalculation of the Atomic Weights," by F. W. Clarke, Revised Edition, 1897, page 364, "Smithsonian Miscellaneous Collection" No. 1075:

H=1.

Found.	Sought.	Factor.	Logarithm.
$(NH_4)_2PtCl_6$	N_2	0.06328	8.801183
	$2NH_3$	0.07689	8.885889
	$2NH_4Cl$	0.24122	9.382409
Sb_2S_3	Sb_2	0.71455	9.854035
As_2	As_2O_3	1.31999	0.120571
As_2S_3	As_2	0.60924	9.784790
	As_2O_3	0.80419	9.905359
$BaCO_3$	CO_2	0 22291	9.348188
$BaSO_4$	Ba	0.58855	9.769781
	BaO	0.65707	9.817614
	S	0.13735	9 137836
	SO_3	0.34293	9 535202
	SO_4	0.41145	9.614320
$CaCO_3$	Ca	0.40082	9.602409
	CaO	0.56021	9.748350
	CO_2	0.43979	9.643246
CaO	Ca	0.71459	9.854059
	$CaCO_3$	1.78505	0.251650
$CaSO_4$	Ca	0.29428	9.468759
	Cao	0.41181	9.614700
	$CaCO_3$	0.73511	9.866350
CO_2	C	0.27289	9.435998
Cr_2O_3	Cr_2	0.68476	9.835536
CuO	Cu	0.79899	9.902540
Cu_2S	Cu_2	0.79863	9 902346
	2CuO	0.99956	9 999807
	Cu_2O	0 89910	9.953805
Cl	NH_4Cl	1.50966	0 178881
	KCl	2.10346	0,322936
	NaCl	1.65037	0.217581
Fe_2O_3	Fe_2	0.70008	9.845146
	2FeO	0.90002	9 954254
Fe_2	2FeO	1.28561	0 109110
	Fe_2O_3	1.42842	0.154855
	Fe_3O_4	1.38082	0.140136

Found.	Sought.	Factor.	Logarithm
$PbSO_4$	Pb	0.68292	9.834369
	PbS	0.78877	9.896950
$Mn_2P_2O_7$	Mn_2	0.38719	9.587919
	2MnO	0.49986	9.698847
Mn_3O_4	Mn_3	0.72046	9.857611
$Mg_2P_2O_7$	Mg_2	0.21816	9.338772
	2MgO	0.36191	9.558598
	$2MgCO_3$	0.75731	9.879273
	P_2	0.27872	9.445165
	P_2O_5	0.63809	9.804883
Pt(from$(NH_4)_2PtCl_6$)	2N	0.14405	9.158503
	$2NH_3$	0.17507	9.243209
	$2NH_4Cl$	0.54920	9.739729
K_2PtCl_6	K_2	0.16103	9.206922
	2KCl	0.30697	9.487008
	K_2O	0.19397	9.287740
2KCl	K_2O	0.63189	9.800640
K_2SO_4	K_2O	0.54061	9.732883
SiO_2	Si	0.47014	9.672224
AgBr	Br	0.42553	9.628930
	HBr	0.43090	9.634370
AgCl	Cl	0.24724	9.393121
	HCl	0.25427	9.405294
	Ag	0.75276	9.876655
AgI	I	0.54030	9.732634
	HI	0.54459	9.736072
NaCl	Na	0.39407	9.595570
2NaCl	Na_2O	0.53088	9.724956
Na_2SO_4	Na_2	0.32429	9.510928
	Na_2O	0.43682	9.640305
	2NaCl	0.82290	9.915349
SnO_2	Sn	0.78814	9.896602
H_2O	H_2	0.11186	9.048662
ZnO	Zn	0.80344	9.904954

Editorial Notes.

Within recent years there has been no field of geology which has produced more abundant and fruitful results than that of glaciology. So many able workers have cultivated it that it has become difficult for any save the specialist to keep pace with the developments, and every teacher of geology has felt the great need of some work of moderate size, for his own information or for placing in the hands of his pupils for collateral reading. Such a work, by Prof. I. C. Russell,* has just appeared, and teachers of Geology, will heartily welcome it. In his "Glaciers of North America" is given a sufficiently full discussion of the science of glaciers in general, their origin, flow, physical features, effects their bearings on climate, etc., together with a detailed description of the North American glaciers, big and little. The work is clear, it is interesting, it is most admirably illustrated and the author's reputation as a geologist is a sufficient guarantee of its accuracy. No continent offers better material for the study of glaciers than does our own, and now their science is put into an available shape for both teacher and student.

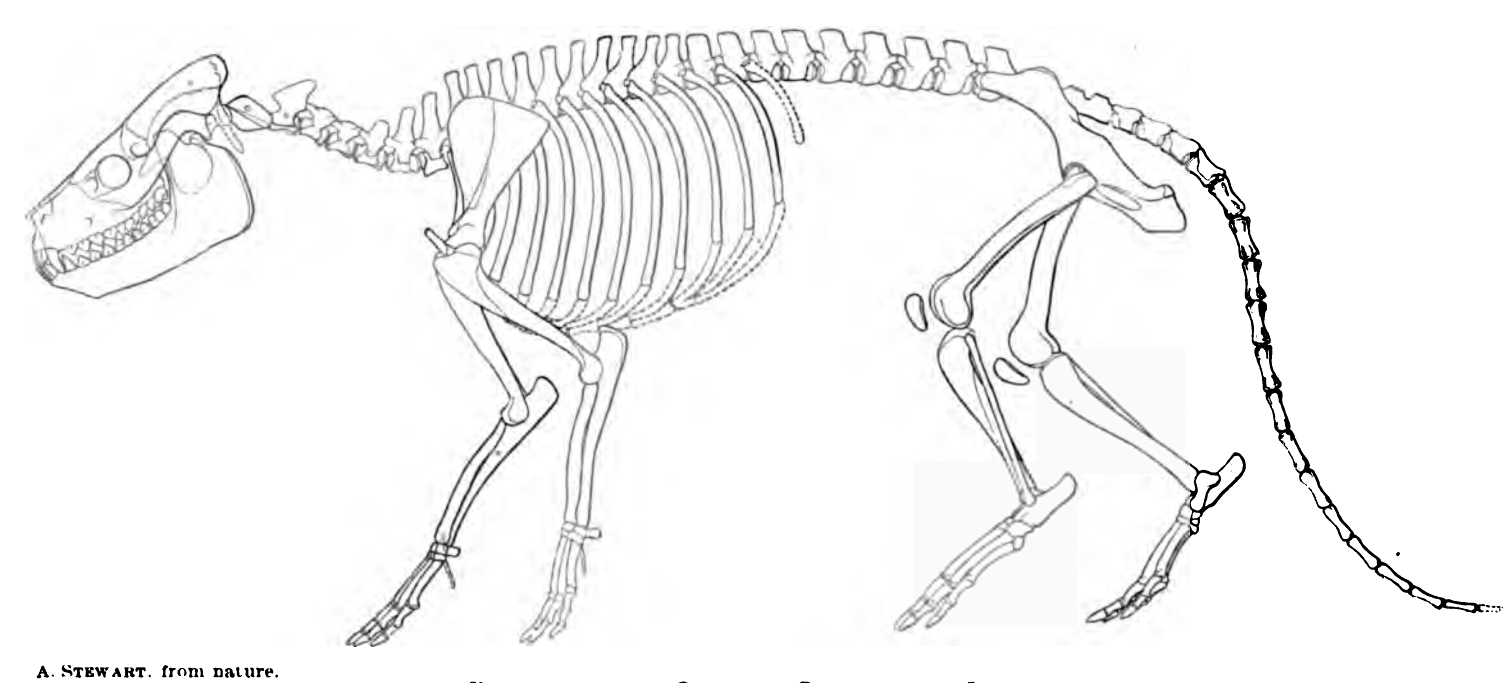
S. W. W.

During the past year there have appeared three most excellent works in general entomology. All are indispensable, supplying, as they do, the different needs of the student. The first and most pretentious of these is by Dr. D. Sharp in the "Cambridge Natural History." Dr. Sharp's extraordinary acquaintance with the literature of insects, as editor of the Zoological Record, has given him the ability to produce a most excellent and readable work of general reference for the library.

The "Manual for the Study of Insects," by Prof. J. H. Comstock is a text book for use in colleges and universities where systematic and structural entomology are pursued, and in these fields it is unequalled. For the first time it permits the student to ascertain to which families the insects that he studies belong. The figures, by Mrs. Comstock, are nearly all new, a feature that is welcome, and, best of all, they are very accurate and clear.

The third work, "Economic Entomology," by Prof. J. B. Smith, while not as extensive as Prof. Comstock's work, is one that is most heartily welcome. It has no rival in its own field, that of applied entomology and is also an excellent adjunct in systematic entomology. Prof. Smith's long experience in both economic and systematic entomology has well fitted him for the task he undertook, and he is to be congratulated upon the success with which he has accomplished it. S. W. W.

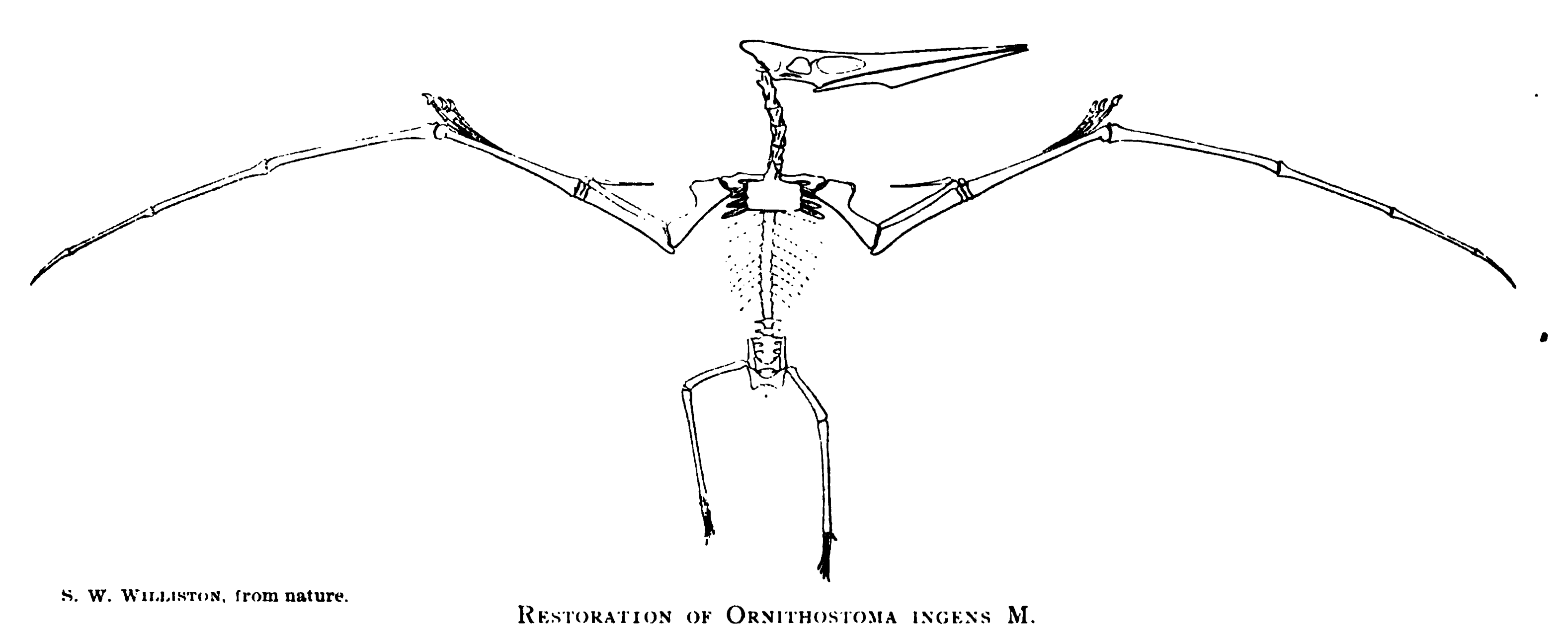
*Glaciers of North America. A Reading lesson for students of Geography and Geology. Ginn & Co., 1897.



A. STEWART. from nature.

RESTORATION OF OREODON CULBERTSONII LEIDY.

Oreodon Beds, White River Miocene. One-fifth natural size.



S. W. Williston, from nature.

Restoration of Ornithostoma ingens M.

Niobrara Cretaceous, Western Kansas One-thirtieth natural size.



PERMIAN BLUFF AT MANHATTAN, KANSAS.

Gypsum Beds Near Top.

(Photographed by E. Haworth, 1895.)



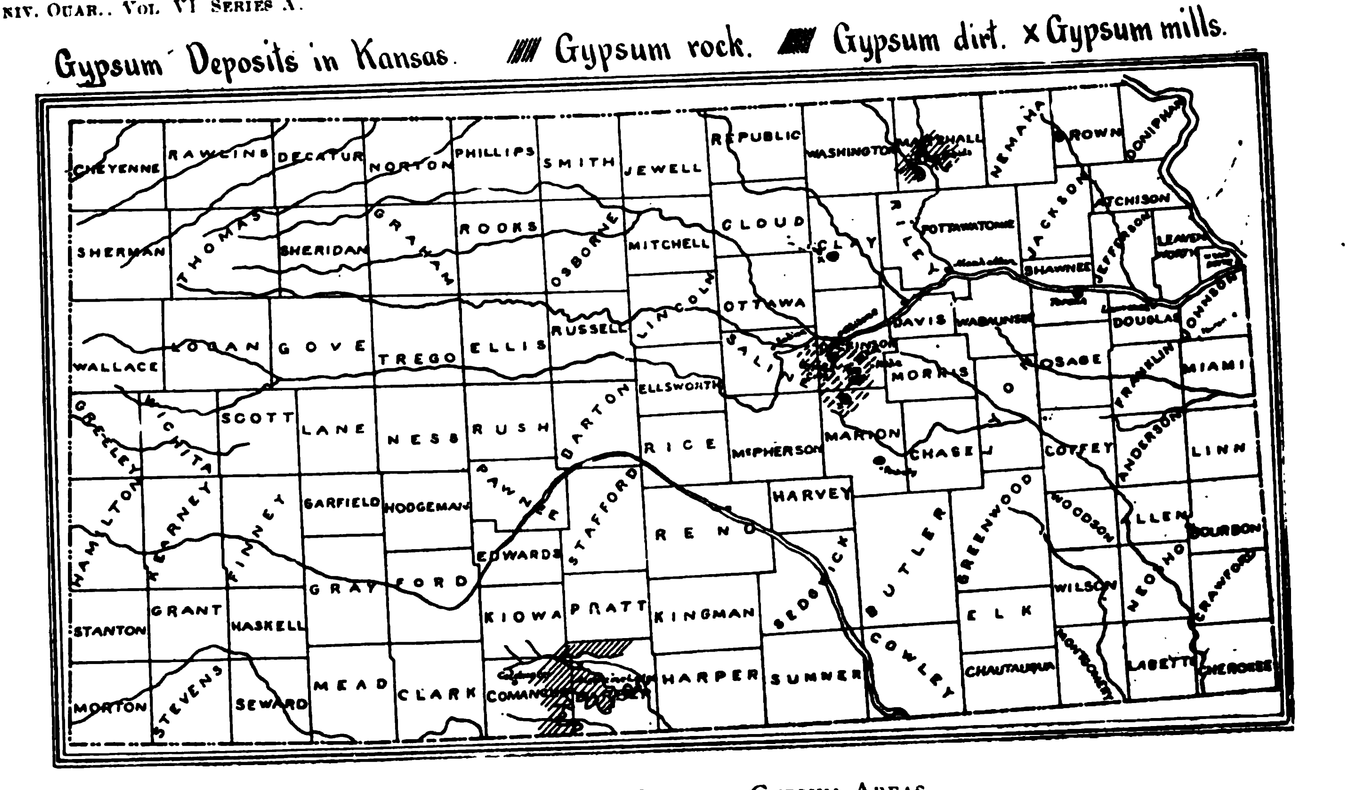
FLOWER POT MOUND, RED BEDS HILL, NEAR MEDICINE LODGE, KANSAS.

(Photographed by C. S. Prosser, 1896.)



MANSARD HILLS IN RED BEDS, NEAR MEDICINE LODGE, KANSAS.

(Photographed by C. S. Prosser, 1896.)



By G. P. Grimsley.

Map of Kansas, Showing Gypsum Areas.

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SERIES A:—SCIENCE AND MATHEMATICS.

CONTENTS.

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Types of Projective Transformations in the Plane and in Space.

BY H. B. NEWSON.

With Plate I.

The object of this paper is to determine the different types of projective transformations in space and to classify them according to their invariant figures. In order to do this it will be necessary to summarize the results already known for one and two dimensions, and to state the principles which will be used in the development of the method here employed.

§1. Types of Projective Transformations in one Dimension.

The one dimensional transformations* which we shall have occasion to make use of in this paper are the transformations of the range of points on a line, of the pencil of lines through a point, and the pencil of planes through a line. We know that there are just two types of projective transformations of a one dimensional form, viz: the kind that leaves invariant two distinct elements, either real or imaginary; and the kind that leaves invariant two coincident elements. By elements of a one dimensional form are understood the points of a range, the rays of a flat pencil and the planes of an axial pencil.

There are only two types of transformations of a one dimensional space. Type I leaves two distinct elements invariant; type II leaves two coincident elements invariant.

Much use will be made in this paper of the following theorem.

*Throughout this paper the word *transformation* must always be understood to mean projective transformation.

A projective transformatfon which leaves invariant three elements of a one dimensional space is an identical transformation and leaves every element of the space invariant. (Lie: Continuierliche Gruppen, S. 117.) In the case of a transformation of the second type leaving two coincident elements invariant one other invariant element suffices to render the transformation identical.

§2. Types of Projective Transformations in the Plane.

A projective transformation of the plane is a self dualistic transformation in the sense that it is both a point to point and a line to line transformation, and hence every plane figure invariant under a projective transformation must be a self dualistic figure. This necessary condition will often enable us to determine whether any given plane figure can be the invariant figure of a projective transformation.

Every type of transformation in the plane is characterized by its invariant figure. We assume the well known theorem that the most general form of projective transformation in the plane leaves a triangle invariant. Proceeding from this fact it is easy to enumerate all the special forms of the invariant figure, and thus all the types of projective transformations in the plane. We shall in this way determine five types (Fig. 1, Pl. I,) of transformations in the plane, of which type I is the kind of transformation whose invariant figure is a triangle. In this case the one dimensional transformations along the invariant sides and through the invariant vertices are all of the first kind leaving two elements invariant.

If two vertices of the invariant triangle of type I coincide, then two sides must also coincide. The change is a self dualistic change and the modified figure is also a self dualistic figure. This is the invariant figure of type II. The one dimensional transformations of the range along AB and of the pencil through A are both of the first kind; those along b and through B are both of the second kind.

If the two points A and B of the invariant figure of type II coincide while the lines b and c do not coincide, the resulting figure is not self duatistic; the same is true if the two lines c and b coincide, but not the points A and B. Neither of the resulting figures is self dualistic, and hence there are no types of transformations in the plane characterized by these figures. But if A and B coincide and at the same time b and c, the change is self dualistic and also the modified figure. This gives us type III. The one dimensional transformation along the invariant line is of the second kind; so also is that of the pencil through the invariant point.

A projective transformation of the plane which leaves invariant four points of the plane, no three of which lie on a line, is an identical transformation and leaves every point of the plane invariant. It may happen, however, that a third invariant point is situated on one of the sides of the invariant triangle of type I. In that case every point on this side is an invariant point, and hence every line through the opposite vertex is an invariant line. The resulting figure, which consists of all the points on a line c and all the lines through a point C not on the line c, is self dualistic. This is the invariant figure of a transformation of type IV, which is called a *perspective* transformation. The one dimensional transformations along all lines through C and in all pencils with vertices on c are of the first kind.

A special case of the last figure is when the vertex of the invariant pencil is on the line c of invariant points. This special case is also obtained when we assume a third invariant point on the line c of the invariant figure of type II; likewise when we assume another invariant point on the invariant line of the linear element of type III. The resulting figure is self dualistic and is the invariant figure of a transformation of type V, which is called an Elation.* The one dimensional transformations along all invariant lines and in all invariant pencils are of the second kind, leaving one element invariant.

This completes the list of types of projective transformations of the plane; for if we modify these invariant figures in all possible ways we can get no new self dualistic figures.

There are five types of projective transformations in the plane; each type is characterized by one of the self dualistic invariant figures of Fig. 1.

Lie in Vorlesungen ueber Continuierliche Gruppen, pp. 65-6 and 510-12, has determined all the types of projective transformations in the plane with the same results as given above. See also a paper by the writer in this QUARTERLY Vol. IV, page 243-49. The method here employed is important because it lends itself immediately to the determination of all types of projective transformations in space.

§3. Types of Projective Transformations in Space.

All projective transformations in space are self dualistic, for they transform points into points and planes into planes. Therefore the conditions of dualism employed in last section for determining

*Lie: Continuierliche Gruppen, S. 262.

types of projective transformations in the plane apply equally well to the determination of types in space. A projective transformation in space leaves invariant certain points, lines and planes. In an invariant plane the transformation is two dimensional and must be one of the five types enumerated above or an identical transformation. Along an invariant line and in an invariant pencil of planes the transformation must be either of the first or second kind or identical.

We know that the projective transformation of the most general kind in space leaves a tetrahedron invariant. From this starting point, by the aid of the principles just stated, it is easy to enumerate all the special forms of the invariant figure and hence all the types of projective transformations in space. We shall find in this way thirteen types (Fig. 2, Pl. I), of which type I is characterized by the tetrahedron itself. The two dimensional transformations in the four invariant planes are all of the first kind leaving a triangle invariant. The one dimensional transformations are all of the first kind leaving two elements invariant.

If two vertices of the tetrahedron coincide, then two faces also coincide. The modified figure then consists of three invariant points, three invariant planes, three invariant lines in a plane and three invariant lines through a point. The resulting figure is thus self dualistic and characterizes type II. The two dimensional transformation in the plane ABC is of the first kind leaving a triangle invariant; those in the planes ABl and ACl are both of the second kind.

Let the vertices of the tetrahedron coincide two and two; i. e. let D coincide with A, and C with B. The resulting figure then consists of two points, two planes and three lines not lying in a plane. It is self dualistic in every respect and characterizes type III. The two dimensional transformations in the planes ABl and ABm are both of second kind.

Next let three vertices of the tetrahedron coincide at A, then must three faces of the tetrahedron also coincide. The resulting figure characterizes type IV. It consists of two points, two planes, and two lines. The two dimensional transformation in the plane ABl is of the second kind, that in the plane π is of the third kind.

Finally let all four vertices and all four faces of the tetrahedron coincide. The single invariant point lies in the single invariant plane, and there is an invariant line in this plane through the invariant point. This is best seen if considered as a special case of type IV. If in type IV A be made to coincide with B, the plane π

must coincide with the plane ABl; and also the line l must coincide with the line AB. The two dimensional transformation in the single invariant plane is of the third kind. This invariant figure characterizes type V.

In the five preceding cases if any transformation leaves invariant the invariant figure and one other invariant point not in an invariant plane or one other invariant plane not through an invariant point, the transformation is an identical one, and every point, line and plane in space is invariant. But the transformation is not necessarily identical when an extra invariant point is found on an invariant line or in an invariant plane.

If an extra invariant point is taken in one of the faces of the invariant tetrahedron of type I, but not on an invariant line, then all points in that face are invariant points and consequently all lines through the opposite vertex are invariant lines of the transformation. The resulting invariant figure is self dualistic and characterizes type VI. The corresponding transformation is called a perspective transformation. The one dimensional transformations along the invariant lines and in the invariant pencils of rays and of planes are all of the first kind leaving two elements invariant.

As a special case of the above the vertex of the bundle of invariant rays may lie in the plane of the invariant points. Such a figure is self dualistic and characterizes type VII. All the one dimensional transformations involved in it are of the second kind leaving one element invariant. The transformations of this type are called Elations in space.

It should be remarked that these two types VI and VII are the only types of projective transformations in space that leave all the points of a plane invariant. This can be shown by examining all the possible forms of this kind to be derived from the first five types. If an extra invariant point be taken in one of the invariant planes of type I, the result is type VI. If an extra invariant point be taken in the plane ABC of type II, the result is type VII. If it be taken on either of the planes ABl or ACl, the result is type VI. If such a point be taken in either of the invariant planes of type III, the result is type VII. If such a point be taken in the invariant plane ABl of type IV, the result is type VII. But if taken in the plane π of type IV, the result is type VI. If such a point be taken in the invariant plane of type V, the result is type VII. In all these cases it is understood that the extra invariant point is not taken on an invariant line of the invariant plane. We have thus

exhausted the possibilities and have obtained only the two types VI and VII.

Again, another set of special types may be found by taking an extra invariant point on one or more of the invariant lines of the first five types.

If a transformation leave invariant a third point on one of the edges of the tetrahedron of type I, the one dimensional transformation along that edge is identical and every point of the edge is invariant. The resulting figure characterizes type VIII. It consists of all points on the line AD, the points B and C, and all planes through the line BC. The two dimensional transformations in the planes BAD and CAD are both of the fourth kind; those in the other invariant planes are all of the first kind.

If a third invariant point occur on the line BC of type II, then all points on that line are invariant and the resulting figure characterizes type IX. The two dimensional transformation in the plane ABC is of the fourth kind; the two dimensional transformations in the invariant planes through Al are all of the second kind.

If an extra invariant point occur on the line BC of the invariant figure of type VIII, the resulting figure characterizes type X. The invariant figure consists of all points on two non-intersecting lines and of all lines joining two invariant points. The one dimensional transformations along the invariant lines are all of the first kind. The two dimensional transformations in the invariant planes are all perspective transformations.

In the invariant figure of type II if an extra invariant point is found on the line AB, the resulting figure characterizes type XI. The two dimensional transformation in the plane ABl is of the fourth kind; that in the plane π is of the third kind; that in every plane through AB is of the second kind.

In the invariant figure of type III if an extra invariant point be taken on the line BC, then all points on that line are invariant and also all planes through the line of invariant points. The resulting figure, consisting of all points on a line and all planes through the line, characterizes type XII. The two dimensional transformations in the invariant planes are all of the fifth kind.

In the invariant figure of type IV if an extra invariant point be taken on the line AB, all points on that line and also all planes through Al are invariant. The resulting figure characterizes type XIII. The two dimensional transformation in the plane ABl is of the fifth kind, while the two dimensional transformations in the planes through Al are all of the third kind.

This completes the list of thirteen types. The invariant figures characterizing the last six cases are all seen to be self dualistic. There is in every case an identical transformation along at least one invariant line and in one invariant pencil of planes. The reader may verify that this list is complete by assuming in turn an extra invariant point on each of the invariant lines of the first five types. No new self dualistic figure will be found.

There are thirteen types of projective transformations in space; each type is characterized by one of the self dualistic figures of Fig. 2.

The determination of these thirteen types of transformations is preliminary to the more extensive problem to determine all the continuous groups of projective transformations in space and to classify them according to these thirteen types. The writer has completed the investigation of this problem for a majority of the thirteen types and will soon begin publishing the results.

A New Explosive Compound formed by the Action of Liquid Ammonia upon Iodin.

BY HAMILTON P. CADY.

During the progress of some work on liquid anhydrous ammonia it became necessary to investigate its action on iodin.

Several investigations on the action of dry ammonia gas upon iodin have been carried out from time to time with rather varying results. Bineau* measured the volume of dry ammonia gas absorbed by a weighed quantity of iodin and deduced the formula 3 NH_3, 2I. The product was a brilliant dark blue liquid. Milton† however found a very much smaller absorption, which was not materially increased by cooling to —18°. Raschig‡ made a third investigation in order to clear up these discrepancies, and found that the composition varied with the temperature. At 80° he found the composition NH_3I, at 20° $(NH_3)_3I_2$, at 0° $(NH_3)_2I$, at 10° $(NH_3)_5I_2$. These results were based not on analysis but upon the gain in weight when dry ammonia gas was passed over a weighed quantity of iodin. These are all non-explosive liquids, the last one gives up part of its ammonia when taken from the freezing mixture.

Seamon§ obtained a non-explosive liquid, solidifying at —8° having the composition NH_3I_2 by the action of ammonia gas upon iodin. G. Gore|| mentions the fact that iodin is soluble in liquid ammonia but in the brief abstract given in Watts Dictionary, Third Sup. VIII, Pt. I, p. 74, nothing is said about the products found.

It seemed probable that the action of liquid ammonia upon iodin would be practically the same as that of gaseous ammonia, and that the results would be an addition product. In order to test this conclusion the following experiments were then made:

*Ann. Chim. phys. [3] 15, 80.
†Ann. Chim. phys. [2], 67, 78.
‡A. 241, 253.
§C. N. 44, 188.
||Prov. Roy. Soc. XX, 441.

A few grams of iodin were placed in the bottom of a vacuum jacketed test tube and liquid ammonia was then run in from the wrought iron cylinders in which it was purchased. The whole apparatus was at ordinary temperature, so of course considerable gas preceded the liquid. As soon as this gas came in contact with the iodin the latter melted and a portion of it eyen volatilized. The remainder dissolved in the liquid ammonia, forming a dense black solution. For every 4 or 5 grams of iodin used 25 to 30 cc. of ammonia was added.

The solution was protected from water vapor by a chloride calcium tube filled with soda lime, and being surrounded by a vacuum of course the ammonia evaporated only very slowly.

The color of the solution was at first a dense black through which light could not penetrate, in a few moments, however, it began to change to a yellowish green and in a short time an olive green, crystalline precipitate separated out leaving the liquid above almost clear and colorless. This precipitate was taken up on a perforated platinum spoon washed with liquid ammonia and quickly transferred to a platinum crucible lid and dried over sulfuric acid in a desiccator. If the solution has been properly protected from water and the transfer has been made with sufficient rapidity the dried product is crystalline and has a beautiful olive green color, otherwise it generally melts to a black liquid and afterwards forms black amorphous solid.

The olive green substance is violently explosive, although more stable than nitrogen iodid. It explodes at the slightest touch or on very slight rise in temperature, it does not, however, seem to be more unstable when in contact with wood and paper than it is with other substances. The dried compound is only slightly volatile, much less so than iodin, and may be kept in desiccators for for several days but will generally explode in less than a week. It may be weighed together with the platinum lid upon which it was dried. It is soluble in ether, alcohol, and chloroform, in each case with the evolution of gas. It is insoluble in dilute hydrochloric, sulfuric and nitric acid, but is slowly decomposed by them, generally exploding a few minutes after being placed in the liquid, and always doing so instantly if the acids are concentrated. It is dissolved by potassium iodid in solution, often with explosion. is decomposed and dissolved in very dilute hydrochloric acid and sulfurous acid or hydrogen sulfid, also by potasium hydroxid. In every case gas is evolved during the process of solution and in the majority of cases the experiment is interrupted by an explosion

violent enough to shatter the beaker and then in some case to blow a hole through the crucible lid.

Two determinations of iodin were made by decomposing the substance with sulfurous acid in the presence of very dilute sulfuric acid, acidulating with nitric acid and precipitating with silver nitrate.

No. I. 0.0817 grams substance gave 0.1076 grams AgI.

No. II. 0.1185 grams substance gave 0.1568 AgI.

No. I. I=74.33 per cent.

No. II. I=74.68 per cent.

Calculated for $(NH_3)_3I$=71.26 per cent., $(NH_3)_2I$=78.88 per cent., $(NH_3)_5I_2$=74.85 per cent.

An attempt was then made to determine the ammonia by decomposing the compound in same way, then making the solution alkaline with potassium hydroxid and distilling into known volume of deci-normal sulfuric acid and liberating the excess of acid.

.No. III gave 3.17 per cent. NH_3.

No. IV gave 3.26 per cent. NH_3.

Calculated for $(NH_3)_5I_2$ 25.15 per cent.

As has been said above, gas is always given off when this compound is dissolved. An effort was made to collect and measure this gas but failed chiefly on account of the numerous explosions. About seven out of eight of the samples blew up before they could be decomposed. After trying a great many different methods of decomposing the body in order to determine the nitrogen and failing in all of them, it was finally exploded over mercury, ane the volume of the gas was measured. The products of the reaction were N, NH_4I and I, the latter united with the mercury.

The substance was weighed out on a little platinum cup with a hollow stem welded on to the bottom. An iron wire was then inserted into the stem and the whole introduced into a eudiometer partly filled with a measured quantity of pure nitrogen to act as a cushion. A few cc. of pure electrolytic gas was then run in and the whole exploded. The electrolytic gas in its explosion set off the iodin compound and the gain in volume over that of the pure nitrogen was of course that portion of the nitrogen in the compound which did not combine with the hydrogen and iodin to form ammonia iodid.

0.0869 grams of the compound gave 15.3 cc. nitrogen at 0° 760 m. m.=22.12 per cent. N exclusive of what remained behind as ammonium iodid.

	I	NH_3	N
No. I.	74.33 per cent.		
No. II.	74.68 per cent.		
No. III.		3.17	
No. IV.		3.26	
No. V.			22.12
Av.	74.51	3.22	22.12

3.22 per cent. NH_3 = .57 per cent. H, 2.65 per cent. N. So the body would have the following percentage composition:

	Found	Calculated for HN_3I.
I	74.51	74.70
N	24.77	24.71
H	.57	.59
	99.85	100.00

The compound HN_3I would probably decompose in this way when treated with sulfurous acid:

$$6\ HN_3I+3H_2SO_3+3H_2O=2NH_4I+4HI+3H_2SO_4+8N_2$$

and this would yield 3.33 per cent. of its weight of NH_3, agreeing well with what was found.

If the compound had been analyzed in the way that nearly all the nitrogen iodid compounds have been, by dissolving the moist substance in HCl and determining the ratio of NH_3 to I it would have given the ratio N to 3I.

The molecular weight could not be determined because the substance decomposed in all solvents, so it is impossible to say whether it is HN_3I or a multiple.

The reaction for the formation of this substance may be represented as follows:

$$11\ NH_3+9I=HN_3I+8NH_4I.$$

No hydrogen is liberated during the reaction and ammonium iodid is found in the mother liquor, so the above reaction must be essentially correct.

No corresponding reaction takes place with bromin and chlorin. Ammonium bromid or chlorid and nitrogen are the only products.

So we may conclude that the action of liquid ammonia upon iodin is not the same as that of gaseous ammonia and that in one case substitution products are found and in the other addition products.

As to the constitution of the body nothing definite can be said at present. The formula

$$\begin{array}{l} \quad\ \ -N-I \qquad I-N- \\ H-N \qquad\qquad\qquad\qquad N-H \\ \quad\ \ -\acute{N} \text{———} \acute{N}- \end{array}$$

suggests itself but is rather contradicted by the fact that NH_4I, N, and HI are formed by the action of sulfurous acid and water upon it and not hydroazoic acid as would be expected. It might also have the formula

$$\begin{array}{l} H-N\geqslant \qquad \leqslant N-H \\ \quad N=I-I=N \\ \quad \acute{N}\leqslant \qquad \geqslant \acute{N} \end{array}$$

But nothing is known which tends to favor this view. In fact it seems useless to speculate until some means can be found for determining its molecular weight. The intention is to continue this work in order to see whether by more extended study its structure can be made out.

The Effect of Magnetism Upon the Spectral Lines of Sodium.

BY A. STC. DUNSTAN, M. E. RICE, AND C. A. KRAUS.

Dr. P. Zeeman (Phil. Mag. March, 1897,) has announced the discovery of an effect of magnetism upon radiation. Analyzing by means of a concave grating the light radiated from a sodium flame placed between the poles of an electromagnet, he finds that upon exciting the magnet, the spectral lines are very decidedly broadened. Upon cutting off the exciting current the lines regain their usual appearance.

Zeeman also gives a number of other experiments which seem to show that the effect is not due simply to changes of pressure in the flame but is caused by a real influence of magnetism upon the radiations emitted. He considers his results to be confirmatory of the theory of Lorentz.*

The discovery considered from a theoretical standpoint is one of great importance, in that it establishes another relation between magnetism and light and is in accord with the electromagnetic theory.

The subject, therefore, seemed to the writers to be worthy of quantitative investigation, and this paper is for the purpose of giving an account of preliminary measurements of the phenomenon.

METHOD.

For the purpose of determining the breadths of the spectral lines and the distribution of light in the same the writers have used Michelson's Interferometer, which succeeds precisely where the diffraction grating fails: i. e., in the analysis of a single line or narrow group of lines.

A full description of the instrument is given below.

APPARATUS.

The light under examination was that given off by a bunsen flame, colored by a piece of asbestos saturated with NaOH solution and wrapped around the top of the bunsen burner.

*"La Theorie Electromagnetique de Maxwell." Leyde 1892. "Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Korpern." Leiden 1895.

The flame was turned low, not over five centimetres in h...
The flame was placed between the poles of an electromag...
By means of a screen, B, with a .75 cm. hole, light was use...
that portion only of the flame which was just between th...
pieces.

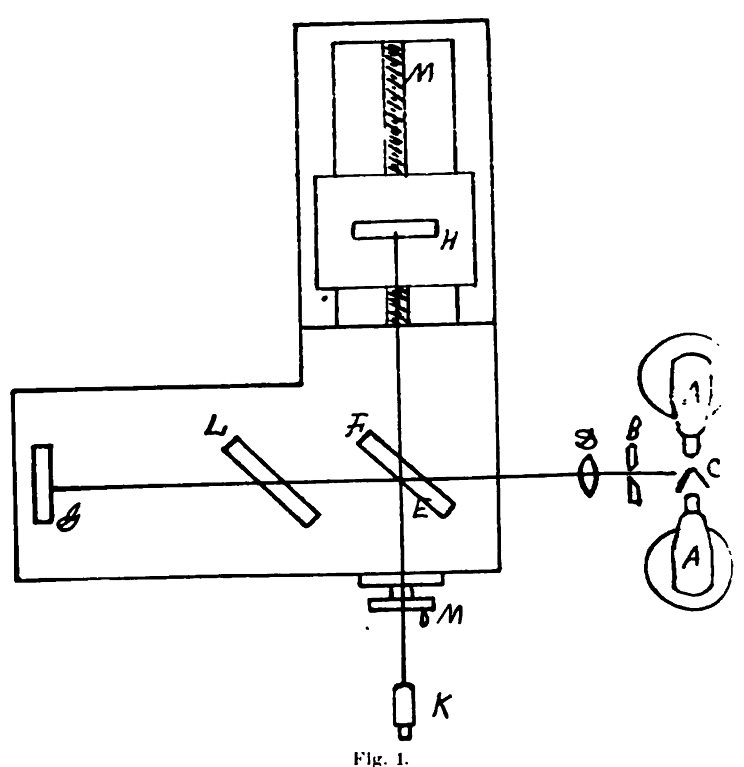


Fig. 1.

The general arrangement of the interferometer is shown in F...
1. Light from the flame C is rendered slightly convergent by ...
collimating lens D and falls upon the semi-silvered surface E o...
plane parallel glass F. Here the beam of light is divided, ...
part (approximately half) being transmitted to the mirror G, ...
other part reflected to the mirror H. After reflection at the mirr...
G and H the two pencils reunite at the surface E; part of the fir...
pencil being reflected and part of the second transmitted to ...
telescope K or to the unaided eye.

The two plane parallel glasses F and L are set at an angle ...
45° with the mirrors G and H, and the distances of the two mirrors
G and H from the semi-silvered surface E are at first made appro...
imately equal by turning the screw M. The parallel glass L ac...

as a compensator, so that the two pencils shall have traversed equal thicknesses of glass before reaching the eye.

Under these conditions, after adjusting slightly the mirror G, the observer will see a series of brilliant interference bands.

By turning the screw M so as to increase slightly the distance of the mirror H from the surface E, thereby increasing the difference of path of the two interfering pencils, and suitably adjusting the mirror G, the interference bands, or fringes, can be made circular and concentric. It is upon the "visibility" or distinctness of these concentric circular interference fringes, as the difference of path is further increased and the magnet excited or not excited, that the results stated in this paper are based.

The fringes were observed by means of the telescope K, focused for parallel rays.

The observations consist in estimating the "visibility" or distinctness of these fringes for successive differences of path of the interfering pencils. Curves are then plotted, using differences of path in mms. as abscissas and visibilities expressed as a proper fraction, as ordinates. From these curves the distribution of light in the source may be deduced, which distribution may also be expressed by a curve with wave lengths in Angström units as abscissas and intensities expressed as a proper fraction as ordinates.

Michelson (Phil. Mag. Vol. 31, p. 338, and Vol. 34, p. 280,) has discussed fully the theory of the interferometer, which he shows will give the same interference phenomena as would be given by two plane luminous surfaces vibrating in the same phase, making a small angle with each other. When the mirror G is adjusted so as to show circular fringes, the angle between the two luminous surfaces is zero. It is under these conditions that we have used the instrument, consequently we give the theory only for this case.

If the distribution of light in the source is given by $y = \phi(x)$ where y is intensity and x is expressed in differences of wave numbers, measured from the mean wave number of the source, Michelson has shown that the "visibility", V, is given by $V^2 = \frac{C^2 + S^2}{P^2}$.

Where;

$$C = \int \phi(x) \cos 2\pi D x dx$$

$$S = \int \phi(x) \sin 2\pi D x dx$$

$$P = \int \phi(x) dx$$

D being the difference of path of the interfering penc
(read from the screw M). The limits of integration are
as to include the entire source. The visibility, V, is def
difference of intensities of a bright and a dark band divi
sum of these intensities, or algebraically $V = \frac{I\ bright - I}{I\ bright + I}$

And it has also been shown by Michelson's investig
eye estimates of visibility agree fairly with the true valu

The distribution of light in the source resulting from
law of molecular velocities is given by $\phi(x) = \epsilon^{-\frac{px^2}{a^2}}$ a
been further shown experimentally that the actual dist
light in a single spectral line in most cases approximates
that given by the formula. The visibility curve resulti
single line with this distribution is $V = \epsilon^{-\frac{\pi^2 n^2}{p}}$ and for
consisting of two such lines, the distribution in each bein
the above formula, the visibility is given by

$$V = \epsilon^{-\frac{\pi^2 n^2}{p}} \left\{ \frac{1 + r^2 + 2r\cos 2\pi Da}{1 + 2r + r^2} \right\}^{\frac{1}{2}}$$

Under the conditions of temperature and pressure ex
bunsen flame this formula represents very well the visib
given by the yellow sodium lines.

For convenience of calculation this formula may be
form

$$V = A2^{-\frac{D^2}{\triangle^2}} \left\{ \frac{1 + r^2 + 2r\cos 2\pi Da}{1 + 2r + r^2} \right\}^{\frac{1}{2}}$$

and $\phi(x) = 2^{-\frac{x^2}{\delta^2}}$

In these expressions A is a constant not greater than
the ratio of intensities of the two lines constituting the s
a quantity proportional to the distance between the cen
lines in wave numbers, and D is the difference of path i
the two interfering pencils as determined by the screw M

$\triangle$ is a quantity which varies inversely as the half brea
of the lines in the source.

The formula shows that the visibility is a periodic f
the difference of path D, and hence that as the differenc

gradually increased the visibility passes through successive maxima and minima. These maxima will touch the curve given by $V = A2^{-\frac{D^2}{\triangle^2}}$ and hence steadily decrease as the difference of path becomes greater. Hence this envelope, determined by observation at points of maximum visibility will give a curve expressed by $A2^{-\frac{D^2}{\triangle^2}}$ and from this curve may be determined A and $\triangle$; where $\triangle$ is the abscissa of the point at which $V = \frac{1}{2}A$ and A is the visibility at the point where D=o.

It may be proved further that $\triangle$ is connected with δ, the half width of the line in the source by the expression $\delta = \frac{\log \epsilon 2}{\pi \triangle}$ and hence from the value of $\triangle$ may be determined the width of the line.

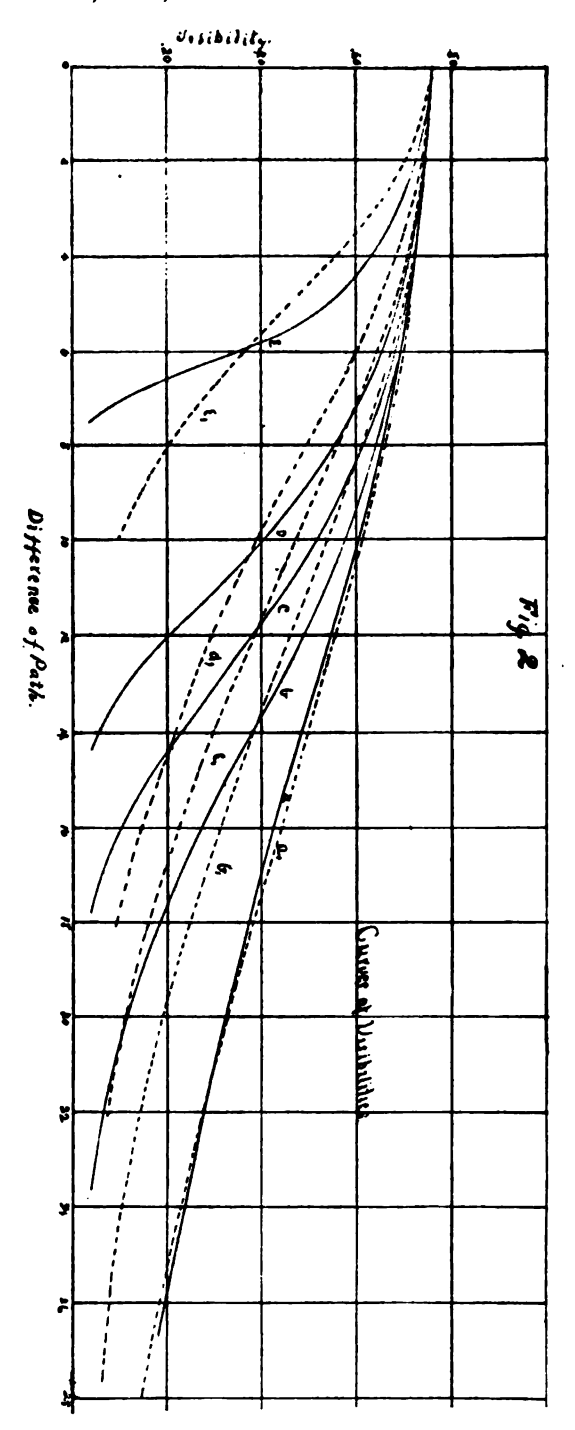
The magnet used was a large one with movable pole pieces. It was capable of carrying a current of fifty amperes for short periods, and this current was used in some of our experiments. The space between the pole pieces varied from 3 to .75 cm. and thus gave a great range of field intensities. Field intensities were measured by means of exploring coils of known area, which were suddenly jerked out from between the pole pieces. The throw of a Horizontal Pattern D'Arsonval Ballistic Galvanometer, which was connected through a resistance box to the exploring coil, gave data for the calculation of the strength of the magnetic field. In order to avoid error due to damping, which in this form of galvanometer is considerable, the exploring coil was arranged so that it broke the circuit immediately upon being jerked out of the field and hence left the damping of the galvanometer the same as upon open circuit. By changing the resistance in the box the galvanometer throws were kept nearly constant in magnitude and hence the errors due to damping, reduction to arc, etc., were avoided.

The galvanometer constant was determined by means of an Elliott standard condenser and two Carhart-Clark cells.

For each position of the pole pieces a curve, whose co-ordinates were strength of field and exciting current, was drawn, thus enabling the strength of field to be interpolated from an ammeter reading. The two exploring coils used were wound with a single layer of No. 36 wire and had total areas of 102.37 and 34.99 square centimeters respectively.

OBSERVATIONS.

SERIES I.			SERIES II.		
D in Millimetres.	Visibility	Intensity of Magnetic Field.	D in Millimetres.	Visibility	Intensity of Magnetic Field.
3.52	.70	0	1.76	.78	0
"	.70	1166	"	.78	7843
"	.70	1878	2.26	.78	0
"	.70	2950	"	.76	7843
4.68	.70	0	2.82	.75	0
"	.70	1166	"	.72	7843
"	.70	1878	3.38	.75	0
"	.70—	2950	"	.70	7843
6.38	.68	0	4.00	.75	0
"	.68	1166	"	.68	7843
"	.66	1878	4.62	.74	0
"	.66	2950	"	.64	7843
8.10	.65	0	5.20	.70	0
"	.65	1166	"	.60	7843
"	.64	1878	5.78	.70	0
"	.56	2950	"	.45	7843
10.44	.60	0	6.38	.65	0
"	.55	1166	"	.29	7843
"	.55	1878	6.98	.63	0
"	.40	2950	"	.10	7843
12.12	.55	0	7.58	.60	0
"	.54	1166	"	.04	7843
"	.35	1878	8.18	.57+	0
"	.20—	2950	"	.00	7843
12.70	.53	0	18.32	.20+	0
"	.48	1166	20.82	.15	0
"	.30	1878	23.92	.10—	0
"	.10+	2950			
13.20	.50	0			
"	.43	1166			
"	.30	1878			
"	.12	2950			
13.90	.47	0			
"	.37	1166			
"	.25	1878			
"	.05	2950			
14.48	.45	0			
"	.35	1166			
"	.06	2950			
"	.20+	1878			
15.06	.45	0			
"	.15	1878			
"	.04	2950			
"	.30	1166			
15.64	.45	0			
"	.04	2950			
"	.30	1166			
"	.10	1878			
16.18	.43	0			
"	.09	1878			
"	.25	1166			
"	.00	2950			
16.79	.40	0			
"	.25	1166			
"	.07	1878			
17.96	.37	0			
"	.20	1166			
"	.05	1878			
19.08	.35	0			
"	.15	1166			
20.26	.35	0			
"	.10	1166			
23.78	.30-	0			
"	.05	1166			
24.44	.28-	0			
"	.06	1166			


Visibility.
Difference of Path.
Fig. 2
Curves of Visibility

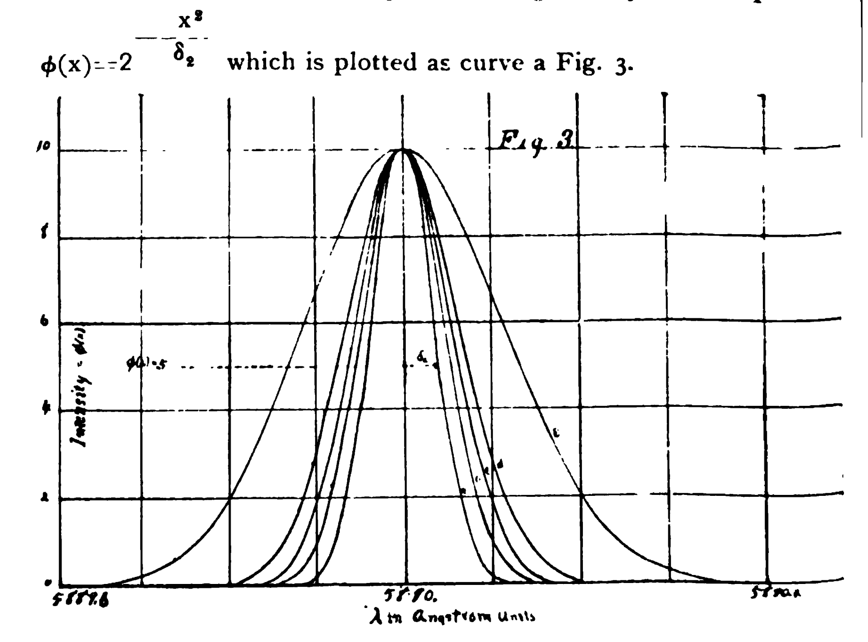
In making his estimates of visibility the observer was kept in ignorance of the field strength or whether the magnet was excited at all. The visibilities for the second set of observations, which were taken on another day, are all multiplied by [illegible] before plotting in order to reduce them to the same initial ordinate as the others.

RESULTS.

In Fig. 2 curves a to e are the visibility curves for maxima, plotted from the preceding observations.

Curve a, Magnetic Field = 0 C. G. S. units.
Curve b, Magnetic Field = 1166 " "
Curve c, Magnetic Field = 1878 " "
Curve d, Magnetic Field = 2950 " "
Curve e, Magnetic Field = 7843 " "

It is seen that the visibility curves fall off more and more rapidly for increasing field strengths, indicating a general broadening of the spectral line. Curve a agrees very closely with the dotted curve a′, whose equation is $V = .76 \cdot 2^{-\frac{D^2}{18^2}}$ and from which is calculated the half width of one of the sodium lines to be $\delta_2 =$ [illegible] = .0123 wave numbers, which can be reduced to Angström units by multiplying by the factor 3.47 which gives $\delta_1 = .0425$ Angström units. Hence the distribution of light in a single sodium line free from the effect of magnetism is given by the expression $\phi(x) = 2^{-\frac{x^2}{\delta_2}}$ which is plotted as curve a Fig. 3.



Exponential curves b′, c′, d′, e′, of the same form are also drawn through the points of half initial visibility of the curves b, c, d, e, Fig. 2.

It is evident from these curves that the visibility curve has changed form, and hence the distribution of light in the source has been somewhat modified by the influence of the magnetic fields; but still the visibility curves for maxima are non-periodic, and a fair approximation to the form and breadth of the source may be obtained from these exponential curves b′, c′, d′, e′, whose equations are:

$$\text{Curve a}'; \quad V = .76 \times 2^{-\left(\frac{D}{18}\right)^2}$$

$$\text{Curve b}'; \quad V = .76 \times 2^{-\left(\frac{D}{14}\right)^2}$$

$$\text{Curve c}'; \quad V = .76 \times 2^{-\left(\frac{D}{12}\right)^2}$$

$$\text{Curve d}'; \quad V = .76 \times 2^{-\left(\frac{D}{10.2}\right)^2}$$

$$\text{Curve e}'; \quad V = .76 \times 2^{-\left(\frac{D}{5.8}\right)^2}$$

It may be noted in passing that the period of the complete visibility curve is not changed by the influence of the magnetic field, so that the mean distance between the two sodium lines is not thereby altered, but only the distribution of light in each line. Also, that very considerable changes in the bunsen flame itself make no difference in the visibility curves of the sodium lines, and hence the effects observed cannot be explained on the ground of variations in the brilliancy or intensity of the flame.

From the equations of the curves a′, b′, c′, d′, e′, Fig. 2, are calculated the half widths of one of the sodium lines under the influence of various magnetic fields.

The values are:

$\delta_1 = .0425$ Angström units.
$\delta_2 = .0549$ " "
$\delta_3 = .0638$ " "
$\delta_4 = .0750$ " "
$\delta_5 = .1320$ " "

and the curves $\phi(x)$ for the assumed exponential law of distribution of intensities in the source are plotted in Fig. 3 as curvès a, b, c, d, e, whose equations are:

Curve a; $\phi(x)=2^{-\left(\frac{x}{.0425}\right)^2}$

Curve b; $\phi(x)=2^{-\left(\frac{x}{.0549}\right)^2}$

Curve c; $\phi(x)=2^{-\left(\frac{x}{.0638}\right)^2}$

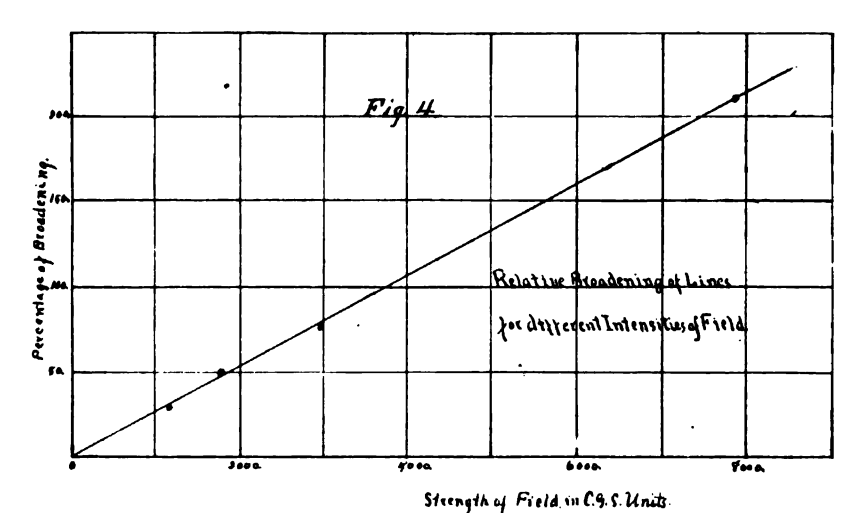
Curve d; $\phi(x)=2^{-\left(\frac{x}{.075}\right)^2}$

Curve e; $\phi(x)=2^{-\left(\frac{x}{.1320}\right)^2}$

The broadening of the lines for field strength, 7843, is given by the ratio $\frac{\delta_5-\delta_1}{\delta_1}=210$ per cent, and similar expressions for the broadening for other field strengths give:

Field Strength.	Percentage of Broadening.
0	0
1166	29
1878	50
2950	76
7843	210

These results are plotted in Fig. 4, and seem to show conclusively



that the broadening is directly proportional to the strength of the magnetic field.

Zeeman, on the basis of Lorentz's theory, deduces that the change of the period of any vibrating molecule, divided by the original period, that is $\frac{T-T'}{T}$ should be equal to $\frac{e}{m}\frac{HT}{4\pi}$ where e is the charge on the vibrating particle in electromagnetic measure, m is the mass of the same particle, H is the strength of the magnetic field in C. G. S. units, T is the original period of the vibrating particle, and T' the period when vibrating in the magnetic field H. Inserting his observed values he finds that $\frac{e}{m}$ is of the order of 10^7 C. G. S. units.

The writers have thought it worth while to attempt a verification of this result from the measures given in this paper.

Let λ be the wave length of the light emitted by some particle in the unbroadened line, then $\lambda \pm (\delta_5 - \delta_1)$ equals wave length of the light emitted by the same particle in the broadened line.

From Lorentz's formula

$$\frac{T-T'}{T} = \frac{e}{m} \cdot \frac{HT}{4\pi}$$

$$T = \frac{\lambda}{v},\ T' = \frac{\lambda \pm (\delta_5 - \delta_1)}{v}$$

Where v is the velocity of light. Then substituting in the formula above,

$$\frac{\delta_5 - \delta_1}{\lambda} = \frac{e}{m} \cdot \frac{H\lambda}{4\pi v}$$

Expressing all quantities in C. G. S. units,

$$\lambda = 5890 \times 10^{-8}, \quad \delta_5 - \delta_1 = .0895 \times 10^{-8}.$$
$$H = 7843. \quad v = 3 \times 10^{10}.$$

This gives

$$\frac{e}{m} = 1.25 \times 10^7.$$

If this number is assumed to represent the ratio between the number of electromagnetic units of electricity on a sodium atom and its mass, a rather interesting conclusion may be drawn as to the order of magnitude of the mass of this atom. For Mr. G. J. Stoney has calculated that for every chemical bond of a monovalent substance ruptured a charge of 10^{-20} coulomb is transferred, or in C. G. S. units 10^{-21}, and if it is further assumed that this is the charge upon a monovalent atom, it follows from inserting this value in the formula for $\frac{e}{m}$ that m equals $.8 \times 10^{-28}$ grams. Using the

value of $e = 17 x 10^{-20}$, given by Budde, the value of m comes out $13.6 x 10^{-28}$ grams.

In conclusion it seems to the writers that their results justify them in stating that the broadening of the spectral lines of sodium is directly proportional to the strength of the magnetic field, and that the broadening of the line for unit field is 11.47×10^{-6} Angström units.

It is proposed to continue this work, extending its scope to include other substances, under various conditions.

Results of Windmill Tests.

E. C. MURPHY.

In Vol. 4, No. 2 of the KANSAS UNIVERSITY QUARTERLY the writer gave the results of some tests of windmills which he made during the summer of 1895. These tests were made with inferior instruments—the only ones then at his disposal—and on small mills operating small pumps raising water mainly for stock purposes.

During the summer of 1896 with much better instruments furnished by the Hydrographic branch of U. S. Geological Survey, he has continued this work testing the large steel mills working large pumps and raising the water for irrigating purposes.

We have also extended the work to include "power" as well as pumping mills. In this paper we wish to give some of the results of these tests, and conclusions to be drawn from them. The complete discussion of results will be found in the forthcoming report of the writer on "Windmills for Irrigation Purposes."

During the season of '95, wind velocity was measured with a small anemometer held on a board at the height of platform of mill. The number of strokes per minute were counted. In '96 the wind velocity was measured with a U. S. Weather Bureau cup anemometer placed on a pole out of the influence of mill and at the height of axis of wind wheel. Each mile of wind and also the number of strokes of pump were recorded electrically on a two pen register. The results of the tests of pumping mills are given in Table I. Examining these results the following conclusions may be drawn:

(1). The power of pumping windmills or the useful work they do is small. None of those tested gave more than .65 of a horse power in a 30 mile wind.

(2). All mills of the same size are not doing the same amount of work. No. 11 for example, is doing twice as much work in a 30 mile wind as No. 3. The chief reason for this is the difference in the load on the mill or the number ft. lbs. of work per stroke of pump. The influence of load on power of mill will be shown in tests of power mills.

(3). Some of the small mills are doing nearly as much work as those of larger diameter. Compare Nos. 9 and 11, also Nos. 12 and 11.

(4). The back-geared steel mills do more work than the direct stroke wooden mills. Compare No. 21 with No. 11 or No. 2. or

TABLE I.

Mill No.	OWNER.	NAME.	Size.	Number of strokes per mile of wind when velocity is — miles per hour.						Number of strokes per minute when velocity is — miles per hour.					
				8	12	16	20	25	30	8	12	16	20	25	30
2	I. L. Diesem..	Woodmansee Mogul.......	12 ft.	....	26	60	61	56	51	....	5.2	16.0	20.3	23.3	25 3
3	—— Carless...	Aermotor	12 ft.	40	60	62	60	56	50	5.3	12.0	16.4	19.8	23 1	25.0
4	E. S. Austin..	Ideal...... ...	8 ft.	....	52	73	76	68	50	....	10.2	19.3	25.3	28.1	25.0
5	Ella Horner..	Aermotor	8 ft.	....	93	94	90	83	77	....	18.6	25.1	29.8	34.6	38.5
6	W. J. James..	Gem	8 ft.	....	62	67	66	61	58	....	12 4	17.9	22.0	25.4	28.5
7	O. V. Folsom.	Aermotor	12 ft.	....	57	59	57	53	47	....	11.4	15.8	19.0	22 1	23 5
8	J. C. Kitchen.	Star......... ..	10 ft.	210	150	.....	...	....	..	28.0	30.0	....	....	....	....
9	F. M. Dunn...	Aermotor	16 ft.	....	53	53	52	47	42	....	10.6	14.1	17 2	19.6	21.0
10	F. M. Dunn...	Ideal	8 ft.	106	125	125	...	....	....	14.1	25.0	33 3	....	....	....
11	F. M. Dunn ..	Ideal.....	12 ft.	....	24	48	57	56	50	....	4.8	12.7	18.8	23 3	25.0
12	D. M. Frost...	Ideal..........	14 ft.	23	55	59	58	52	....	3.1	10.9	15.7	19.2	21 5	....
13	Wm. Coulters	Aermotor	12 ft.	...	55	64	63	50	55	...	11.0	17.1	21 0	24 6	27.5
15	Jas. Allen	Gem	10 ft.	....	39	45	44	35	...	....	7.8	11.9	14 7	14.6	....
16	Jas. Allen.....	Halliday......	10 ft.	30	113	127	128	126	....	4.0	22.6	33.9	42 7	52.5	....
17	D. R. Menke..	Gem	12 ft.	....	30	48	52	....	....	....	6.0	12.8	17.3	....	....
18	Fred. Pile....	Ideal..........	8 ft.	60	101	114 / 98	102 / 84	79 / 66	..	8.0	20.2	26 1	28 0	27.5	....
19	W. E. Trell...	Gem	12 ft.	....	31	45	44	38	....	..	6 2	11 9	14.7	16.0	....
20	W. T. Cowhick	Jumbo.........	15½	....	....	20	32	42	....	....	....	5.3	10 7	17 5	....
21	J. E. Hunt....	Halliday......	12 ft.	....	70	107	112	107	....	....	14.0	28.5	37.3	44 6	....
22	Wm. Brown.	Fairbanks....	8 ft.	92	146	140	144	80	....	12.3	29.2	37.3	38.0	33.3	....

TABLE I—CONCLUDED.

Mill No.	Number gallons pumped per hour when wind velocity is— miles per hour.						Useful work in horse-power when wind velocity is — miles per hour.						Foot lbs. useful work per stroke of pump.	Vane area in square feet.	Lift (feet).	Size of pump*.
	8	12	16	20	25	30	8	12	16	20	25	30				
2	.....	1,131	3,480	4,415	5,069	5,503	....	.085	.260	.322	.379	.411	536.2	69.4	17.75	9⅝x12
3	1,153	2,610	3,567	4,308	5,014	5,437	.067	.151	.207	.250	291	.315	415 3	72 9	13.75	9¼x12
4	......	308	579	759	843	750	....	.015	.029	.038	.043	.038	50 0	36 1	12	5⅝x8
5	......	977	1,318	1,564	1,817	2,021	....	.053	.072	.086	.099	.111	94 9	33 7	13	6x8
6	......	725	1,047	1,287	1,486	1,667	..	.029	.042	.051	059	065	77.6	36.9	9.60	6½x8
7	...	2,445	3,387	4,075	4,740	5,041	...	.160	.221	.266	.309	329	461 9	72 8	15 50	9½x12
8	101	108	...	......	......	......	013	.014	......	......	......	....	15 0	59 8	30	3x5
9	....	1,749	2,326	2,838	3,234	3,465	....	.325	.433	.448	601	644	1,013 3	133 6	44.25	8x16
10	70	125	167	...	......	......	.010	.017	.023	.032	......	...	22 8	42 0	33	2½x6
11	......	648	1,714	2,538	3,150	3,375	....	.123	.325	.481	600	639	843 7	75.3	45	7⅝x12
12	535	1,880	2,708	3,312	3,709	......	025	087	.125	.153	172	....	263 5	103 6	11	6⅝x12
13	......	2,376	3,694	4,536	5,314	5,940	...	.110	171	.210	247	.275	330 0	72 8	11	10x12
15	......	819	1,250	1,543	1,533	......	...	.053	.082	.101	.099	....	219 0	47 3	15	?x8
16	180	1,017	1,526	1,922	2,362	......	.012	.067	.103	.130	.159	....	100 0	61 3	16	6x8
17	....	765	1,632	2,206	.....	....	....	.070	.149	.202	......	....	385 0	75.8	21 75	8x12
18	348	879	1,135	1,218	1,196	......	.022	.054	(.082) .070	(.092) .076	(.088) .074	....	89 2	42 0	14 75	5½x8
19	......	1,116	2,142	2,646	2,880	......	....	085	.162	.201	219	....	450 0	77 6	18	10x10
20	......	......	795	1,605	2,625	......	..	....	.047	.095	.154	....	291.2	73 6	14	Two. 6x12
21	......	945	1,924	2,518	3,010	......	....	.060	121	.159	.184	....	141 5	69.7	15	7⅝x7
22	57	136	173	177	155	....	002	005	.007	008	005	....	5 5	30 2	8½	2½x4

*Inside diameter of cylinder by length of stroke.

any other 12 foot mill. The results of tests of a 12 foot "Power" mill are shown in Fig. 1. The wheel of this mill is like that of mill No. 3. table I. The power was measured with a friction brake on a 9½ pulley which runs the grinder or other machine. The speed of pulley was measured with a Pratt speed indicator.

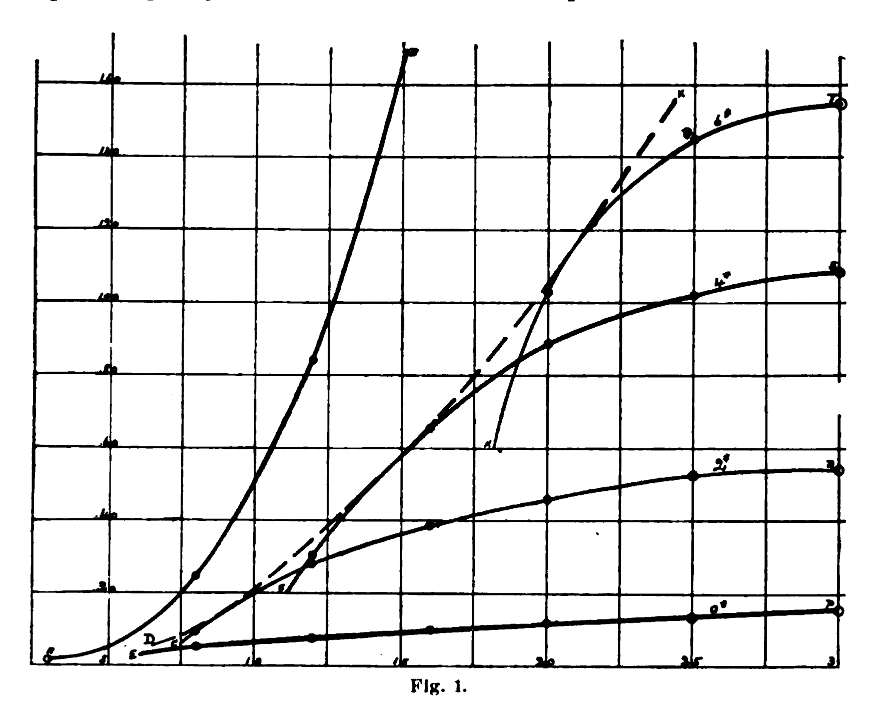


Fig. 1.

The four curves marked o lbs. 2 lbs. 4 lbs. and 6 lbs. give the relation between H. P. and wind velocity in miles per hour. The o curve is for no brake load, the brake was off the pulley The 2 lb. curve is for a brake load of 2 lbs; the 4 lb curve for a brake load of 4 lbs. and the 6 lb. curve for a brake load of 6 lbs.

It is easily seen that the power increases with the load above certain velocities. At 30 miles per hour the power is nearly proportional to the load on the mill This fact which accounts for much of the difference in the pumping power of windmills has never been clearly shown, to the writer's knowledge. We noticed it in our tests made in '95 and stated the fact in the paper already referred to. (p. 104 Vol. 4 KANS. UNIV. QUARTERLY). This fact is also referred to by Mr. J A. Griffiths, Associate Member Institution C. E. in a paper on "Windmills for Raising Water" – published in 1895 in "Proceedings of the Institution of Civ. Eng: Vol. 119. He says "In

spite of the paucity of data the results obtained with this mill show conclusively that the most important element in the efficiency is the pump load factor."

The brake load of 2 lbs. corresponds to a useful pump load of 740 ft. lbs. per stroke. This is somewhat less than the load of mill No. 11 and greater than the average pump load of this size of mill. It is seen that this 2 lb. curve is nearly a straight line for the usual jumping velocities of 10 to 20 miles per hour. That is, the power of a power mill as well as that of a pumping mill increases nearly as the first power of the wind velocity for a constant load of 2 lbs.

The dotted curve D. K. is drawn tangent to these load curves and is the envelop of them. It is very nearly a parabola whose vertex is at the origin, with axis vertical. It is easily seen that this curve gives the relation between wind velocity and horse power for a constantly increasing load on the mill. The power of the mill would be greatly increased by some device for increasing the load of the mill it would then vary as the second power of the velocity instead of the first power.

The curve A. B. gives the relation between wind velocity and horse power for the total energy of the wind which strikes the fans of this mill. That is, if this windmill could utilize all the energy of the wind which strikes the surface of its fans its power would then be given by the curve A. B. which is of the third degree. The efficiency of the mill being the ratio of the horse power developed by the mill to the total horse power of the wind which strikes it, it is seen to be the ratio of the ordinate of any load curve to the corresponding ordinate of curve A. B. It is seen to decrease for a constant load as the velocity increases, and to increase for a constant velocity as the load increases. The maximum efficiency is the ratio of the ordinate of curve D. K. to the corresponding ordinates of curve A. B.

It is seen that the useful work that a windmill will do when working under a constant load at all velocities is small, the horse power varying as the first power of the velocity. By some device for automatically increasing the load as the wind velocity increases the power may be much increased at high velocities, and will then vary as the second power of the velocity. Even with this device for increasing power there is still a great difference between the power possessed by the wind and the power developed by the mill and this difference increases as the velocity increases. The question may be asked--"Why does not the windmill utilize a larger amount

of the energy of the wind?"—Let A. B., Fig. 2, be a strip taken from the outer end of one fan of a windmill; it is curved, but for this purpose it may be considered a plane. This strip makes an angle δ with the absolute direction of the wind. c represents the

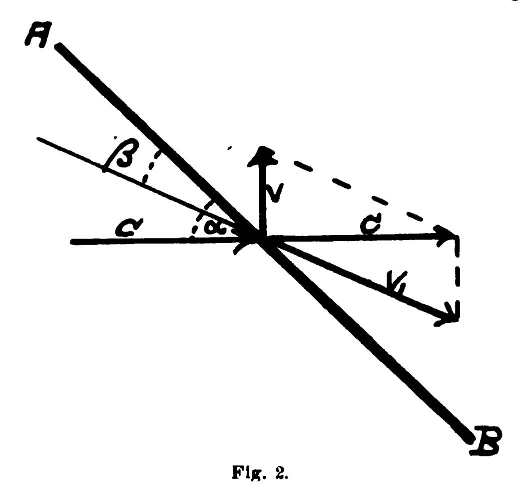


Fig. 2.

amount and direction of the wind, v represents the amount and direction of the velocity of the surface A. B. Then the relative velocity of the wind, that is its velocity with respect to the moving surface A. B. is v_1, the diagonal of the parallelogram constructed on v or c as sides. v_1 makes an angle β with the absolute direction of the wind. If $v=o$, that is, if the wheel is held so that it cannot revolve the angle $\beta=\delta$. As v increases β grows less and less and finally becomes zero in which case v_1, is parallel to surface A. B. In this case the surface receives no pressure from the wind—this portion of the fan is not utilizing any of the energy of the wind.

If v be still farther increased, β becomes negative and the wind pressure is on the opposite side of A. B. This portion of the fan is then doing work on the wind instead of the wind doing work on the fan. The effective wind area of a fan being the projection of the fan on a plane at right angles to the relative velocity of wind over it—that is to v_1, it is seen that as v increases the effective area decreases. The energy which the fan takes from the wind is proportional to the effective wind area. It is seen then that this reduction of effective wind area is the reason why the efficiency is low at high wind velocities. If this effective wind area could be kept constant by some device for changing the angle of the fans then the relation between wind velocity and horse power might vary nearly as a third degree of the wind velocity.

In this discussion we have not taken into account the reduction of wind area due to the wind wheel swinging out of the wind or "regulating." The mill can be built strong enough so that it will not need to regulate for velocities less than 30 miles.

Brachysaurus, a New Genus of Mosasaurs.

BY S. W. WILLISTON.

With Plate VIII.

The University Geological Expedition of 1894 was fortunate in discovering in the Ft. Pierre deposits, of South Dakota, two remarkable specimens of Mosasaurs, one of them representing a new species of Mosasaurus in remarkably perfect preservation, the other a new genus. A brief reference to the most peculiar characters presented by the species representing this genus was given by me in this journal, Vol. III, p. 169, under the specific name Overtoni, from its discoverer, my assistant. I did not feel sure of its distinction from some of the forms previously described, and refrained from giving the genus a name. Its characters are, however, peculiar in so many respects that I venture to more fully describe it in the present communication under the name Brachysaurus.

The horizon whence the specimen was obtained is near the top of the Pierre deposits of the Cheyenne river of South Dakota, and probably a hundred or more feet above that of *Mosasaurus horridus* described by me. It thus, it is seen, represents one of the latest forms hitherto made known from North America. That it may be found identical with some of the forms hitherto described from fragmentary material from New Jersey under names that have been supposed to be synonymous with better known genera, is not impossible. The generic name here proposed is, therefore, in a measure provisional.

The material upon which the genus and species are based is as follows: One mandible nearly complete, both maxillæ, the most of the frontal bone, one quadrate, portions of the very massive pterygoid, and other fragments of the skull; some twenty or more vertebræ in more or less imperfect preservation; both humeri; and two smaller paddle bones. The generic characters, derived from these parts of the skeleton, are as follows:

Brachysaurus, *gen. nov.*

Frontal bone as broad or broader than long, the orbital margins not at all emarginate, the posterior portion projecting in the middle and emarginate for the pineal foramen. Maxillæ very stout, with twelve teeth. Mandibles stout, with fourteen teeth. Teeth very stout, moderately recurved, wholly smooth, without facets, and with an anterior and posterior carina. Supracolumellar process of quadrate long and stout, and broadly co-ossified with the body of the bone below, enclosing a large, oval, auditory meatus, above which is situated the large stapedial pit. Zygosphene of vertebræ rudimentary or wanting; chevrons co-ossified with centra; hypopophyses of cervical vertebræ free; cervical and dorsal vertebræ cordate in outline; pygial and caudal vertebræ subtriangular. Humerus very stout and broad; radial process wanting, the ulnar process stout.

In the absence of other parts of the skeleton, it is not possible to say with certainty to which family the genus belongs. The co-ossified chevrons have hitherto been characteristic of the Mosasauridæ, but the absence of the zygosphene points more to the Tylosauridæ.

Brachysaurus overtoni Williston, Kans. Univ. Quart., iii, 169, 1895.

The quadrate bone has some of the general characteristics of *Mosasaurus horridus*, but the supracolumellar process is much stouter and longer, and is firmly co-ossified below, a unique character among the American forms. The stapedial pit, of large size, is situated below an overhanging ridge, and is much higher up than in the forms used for comparison (*Mosasaurus*, *Platecarpus*, *Clidastes* and *Tylosaurus*). The wing is apparently thin, and is preserved only in part; it does not seem to be of large size. The external auditory cavity is much less expanded than in the other genera, not extending nearly to the inferior margin of the bone. It may not be amiss to state here that this cavity in the Kansas specimens of the order is frequently filled with thick plates of cartilage, which extend through the auditory slit or foramen and surround the stapedial pit to a greater or less degree. The maxillary articulation is elongate, and broader on the outer part.

The mandibles are remarkably stout, and have not more than fourteen teeth implanted in them. I formerly erroneously gave the number as thirteen. The jaws are distinctly convex along their under border and somewhat concave above. The coronary bone is stout, but apparently does not extend as high as in *Mosasaurus* and

Clidastes. The maxillæ are likewise stout, and have twelve teeth implanted in each. The teeth are remarkably stout, much more so than in the other genera, save, perhaps, *Tylosaurus.* They are moderately recurved and are smooth throughout, with a weak carina fore and aft. From the shape of the maxillæ, the length of the lower jaws, and the breadth of the frontal bone, it is quite evident that the rostrum was not much prolonged in front of the teeth.

The frontal bone is remarkably broad and heavy; the orbital borders are convex and apparently free, the prefrontal not being prolonged back to the postfrontal. The strong median projection behind is very different from the usual shape of this part. The borders of the bone are stout and thick.

The cervical and thoracic vertebræ have the centra cordate in outline at the convex end, and are relatively small for so large and broad a head. The cervical hypopophyses are free,* but the process for their attachment is not smaller than usual. The pygial and caudal vertebræ have their outline subtriangular, much as in *Tylosaurus.* The chevrons, in the caudal vertebræ preserved, are firmly co-ossified with the centra.

The coracoid is of the usual shape, and has a deep emargination.

Perhaps the most peculiar of any of the elements preserved, aside from the quadrate, is the humerus. Its proximal end is much thickened, strongly convex from side to side, with a projecting angle at one side of the middle. The deltoid ridge is narrow and proportionally small. There is no radial process, as in *Mosasaurus* and *Clidastes*, but there is a stout ulnar process, with a large round surface, projecting nearly upwards. The free radial border is remarkably short, that of the ulnar side much longer and curving obliquely forward to the ulnar tuberosity.

A single paddle bone (fig. 7) is of such peculiar shape that I can not place it.

Altogether, the animal possessed a remarkably stout and broad head, with stout jaws and teeth, and evidently short, broad and stout paddles, and short body.

Measurements:

Quadrate, total length	130 mm.
Frontal bone, expanse	270
Mandible, length from articulation to extremity	650
" length of dental series	580
" width opposite last tooth	160

*The co-ossification of the cervical hypopophyses is of minor value. A specimen of *Clidastes tortor* Cope in the museum has them firmly united throughout.

Mandible,	width between seventh and eighth teeth	90 mm.
"	heigth of eleventh tooth above jaw	50
"	antero-posterior diameter of same at base of enamel	25
"	total length of jaw	1050
Humerus,	length	140
"	greatest width proximally	100
"	greatest width distally	120
"	length of ulnar border	25
"	length of radial border	60
"	greatest thickness proximally	55

EXPLANATION OF PLATE VIII.

Fig. 1. Mandibular tooth, natural size; *1a*, basal cross-section of the same.

2. Frontal bone, upper surface.

3. Quadrate, inner aspect.

4. Posterior cervical vertebra, anterior aspect; *4a*, the same from below.

5. Caudal vertebra.

6. Humerus, palmar aspect.

7. Paddle-bone.

All figures, save those of the teeth, one-fourth natural size.

On the Extremities of Tylosaurus.

BY S. W. WILLISTON.

With Plates IX-XII.

All that has been published hitherto concerning the extremities of this genus of saurians are the figures of the femur by Marsh*, of the humerus, femur, tibia, fibula and various phalanges by Cope (Cret. Vert.) and a sketch of the front paddle by Professor F. H. Snow.†

The specimen figured by Chancellor Snow—one of the best of the order in our collection—has since been more thoroughly cleaned from the matrix, enabling a more accurate drawing to be made, which is presented herewith. This paddle is the most perfect that I have ever seen in any specimen from the Kansas Cretaceous, and determines some interesting points about which there has been doubt hitherto. A photographic reproduction of the paddle is given in plate IX, as it lies upon the chalk slab. The parts there concealed beneath the ribs and vertebræ have been carefully laid bare from the opposite side and their position is shown in the accompanying outline figure.

This specimen, it will be remembered, is the one in which the excellent casts of the skin are preserved, a figure of which was given by Snow in the paper cited. This engraving is so accurate, that, together with a photographic reproduction of a portion of the cast, (plate XII) additional description is unnecessary. A comparison of the scales with those of the Monitor, from the same region of the body, shows them to be remarkably alike, both in size and shape.

The position of the paddle is evidently a natural one and the fact is of interest as showing the general expansion and general curvature of the digits. The limb is undoubtedly more flexible than is the case with either *Clidastes* or *Mosasaurus*, as is shown by the considerable space between the different bones, which while partly filled out with cartilage, must have left very free articulations.

*Amer. Journ. Sci., 1872.
†Trans. Kans. Acad. Sci., Vol. vi, p. 54.

The scapula, not preserved in connection with the other bones, is of smaller size than the coracoid, and relatively smaller than in either *Clidastes* or *Platecarpus*. At the mesial end of the coracoid there is a thick plate of cartilage of considerable extent and closely united with the bone. Nowhere in this specimen, or in any other

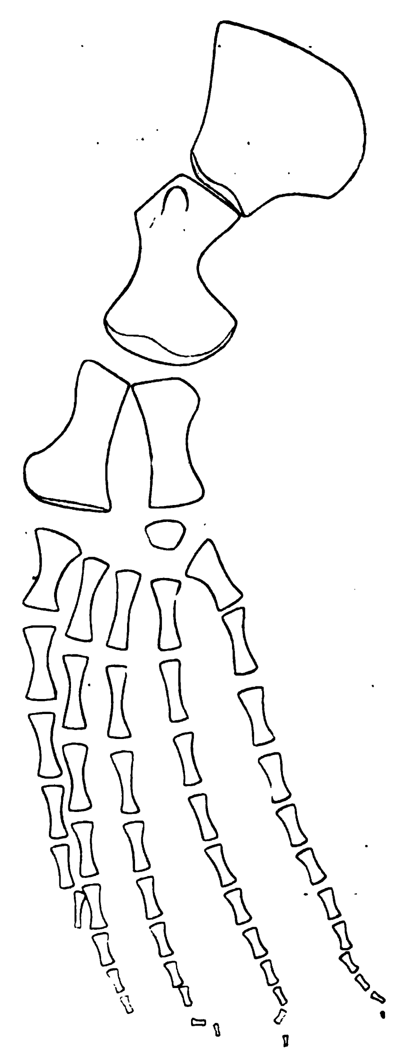


Fig. 1. Front paddle of Tylosaurus.

specimen of this genus that I have seen, is there any indication of a sternum, even a cartilaginous one. Were it existent it would have been most certainly preserved in this specimen, inasmuch as

the skin lies intact in the region where the sternum should have been, so that it could hardly have been lost. There can then seem to be little or no doubt that its absence in this genus, as in all the Tylosauridæ, is a fundamental character of the family, as I have previously defined it. Marsh has figured the coracoids of *Clidastes* as meeting in the middle line, but this is certainly an error. They are separated by a considerable expanse of cartilage as would indeed be expected from the relationship to modern lizards.

In the present specimen remains of the skin are found between the bones, from which it is evident that the membrane was very thin and pliable and extended fully between the fingers to their tips. Small scute-like scales are found as far as the metacarpals, beyond which they are wanting everywhere, apparently. The numbers of phalanges in this specimen were apparently as follows: I–6, II–9, III–10. IV–11, V–11. The distal one is preserved only in the fifth finger, and is, as is seen, very small and imperfect. I am much inclined to the opinion that the number of the phalanges is not always uniform in different individuals of the same species, though probably varying only within small limits. It will be observed that the fifth finger is longer by far than in either *Platecarpus* or *Clidastes*. In this, as in other respects, *Platecarpus* holds an intermediate position between the two genera. *Tylosaurus* is the least lizard-like of the American genera of the Pythonomorpha. The paddles are more slender, more flexible and relatively longer than in the other genera.

The structure of the hind paddle, as shown incompletely in the accompanying photographic illustration, (plate X) is of great interest, as proving, conclusively, I think, that there were five functional toes, though the fifth is evidently undergoing reduction and the first is not as long as in the front paddle. The femur is much more elongate than is the humerus. The tibia is an unusually broad and flat bone; the fibula small and slender. In the front paddle only a single carpal bone is preserved, and I do not think that there were others in the living animal. It is a bony nodule evidently set in a plate of fibro-cartilage, and it is possible that in older individuals there may be additional ones. It is not at all unlikely that the same variations in the number of carpals and phalanges exists in this genus as does among the Cetacea. In the hind paddle the single tarsal preserved is of the same character as the carpal.

Marsh has figured the hind paddle in *Platecarpus*, and I have no doubt of its general accuracy. Dollo suspected that it might be wrong, and that the genus had but four toes, as in *Mosasaurus*.

The shape of the present paddle seems to be not unlike that of *Platecarpus*. The two larger metatarsal bones are undoubtedly the first and fourth, the former in position, the latter displaced proximally, while the displaced smaller phalanges must represent the fifth toe, which is evidently divaricate, as in *Platecarpus*. The fifth metatarsal is probably the short, irregular bone lying contiguous with the fourth metatarsal. The complete hind paddle of *Clidastes* is not known, but I believe that it is like that of *Mosasaurus*, and, if so, there were but four functional toes, as has been shown by Dollo. It is upon this character, together with that of the sternum and others, that I have established the two families, Tylosauridæ and Mosasauridæ, the two typical genera representing the extremes of development in this order of reptiles.

A restoration of *Tylosaurus proriger* will be given in the next number of this journal.

EXPLANATION OF PLATES.

Plate IX. Front paddle of *Tylosaurus proriger*.

Plate X. Hind paddle of *Tylosaurus proriger*.

Plate XI. Pelvic bones of *Tylosaurus*.

Plate XII. Skin of *Tylosaurus*, natural size.

All the foregoing figures are from the same specimen, collected by Prof. F. H. Snow and now in the University Museum.

Two New Species of Asilids from New Mexico.

BY BARNUM BROWN.

Nusa abdominalis, n. sp.

Female. Abdomen red; thorax thinly pollinose; hind tibiæ much curved. Length, 12 millim.

Head black; face and front thickly white pollinose; the former with abundant, long, white hair, moderately protuberant below. Occiput white pollinose, with white hair. First and second joints of the antennæ red; third black, except at the proximal end, dilated distally. Thorax brownish red; mesonotum with a darker median and two large, partly confluent spots on each side; sparsely clothed with short white hairs. Abdomen light red or yellowish red; short, with nearly parallel sides, clothed with short, sparse, decumbent white hair; moderately shining, finely punctate; a single bristle present near the lateral margin of each segment. Legs black, somewhat reddish at base of tibiæ and tarsi; hair short, sparse, white; hind femora considerably thickened distally; hind tibiæ much curved and moderately dilated at the tip. Wings nearly hyaline; first posterior cell closed remote from the border.

One specimen, collected by myself at Cuba, Bernalillo County, New Mexico.

Nusa similis, n. sp.

Female, Like *N. abdominalis*, but differing in the following characters: Antennæ black; third joint not so long as the first two together, thickened distally. Thorax black, densely white pollinose. On the lateral margin of each abdominal segment four bristles present. Hind femora only moderately thickened; hind tibiæ but little curved.

Two specimens, from the same locality as the preceding.

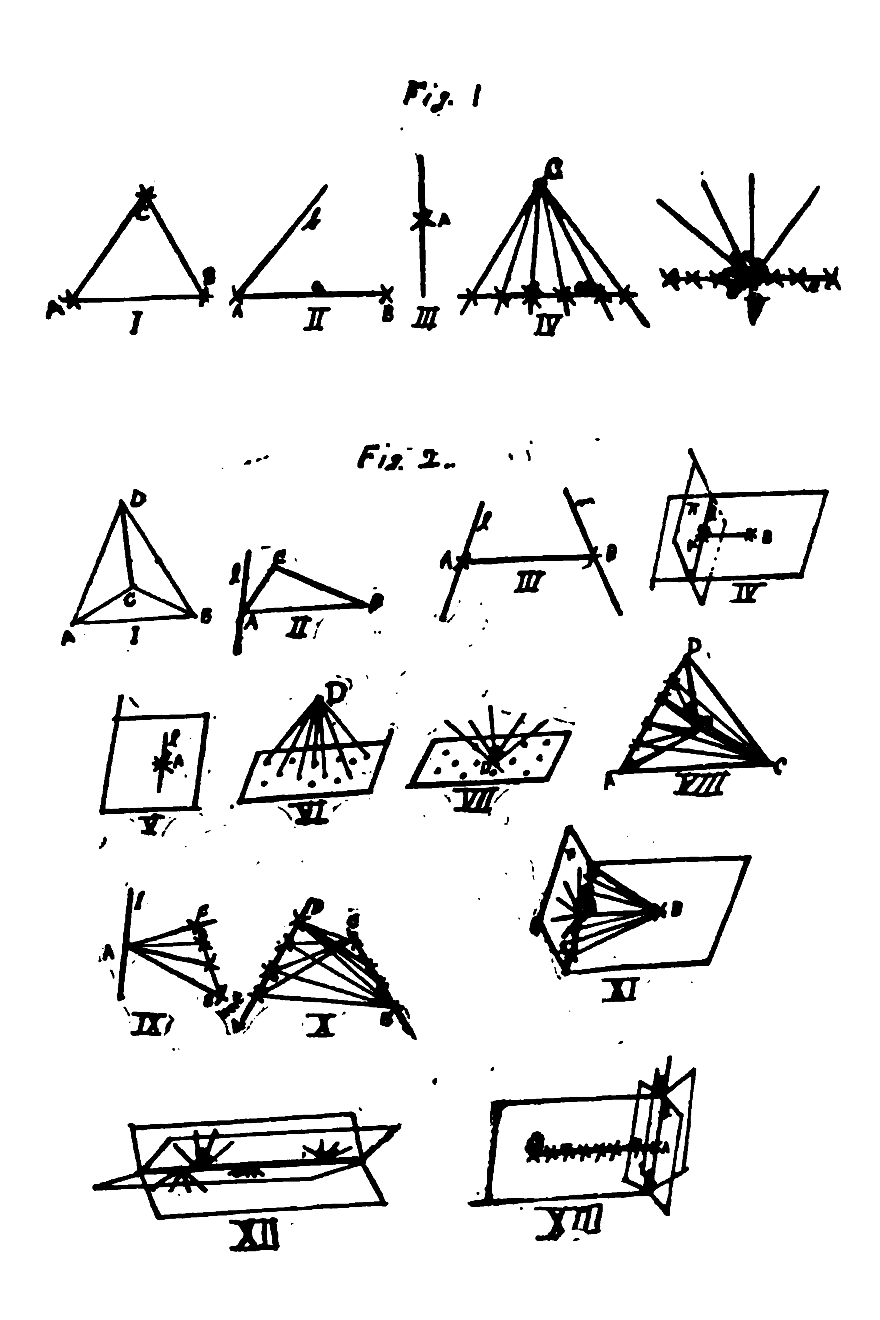
Editorial Notes.

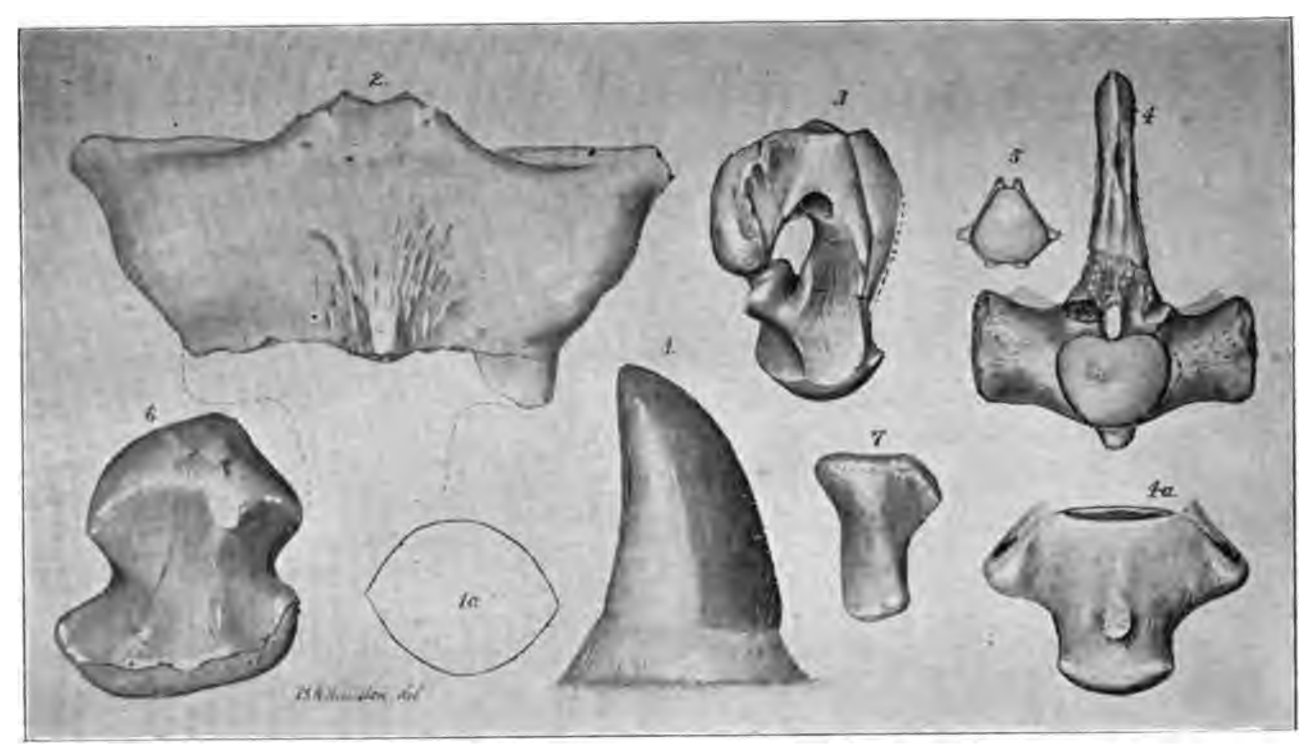
The April number of the Annals of Mathematics contains an article by Prof. H. B. Newson, on Hessians and Steinerians of higher orders. In this paper a substantial advance is made in the theory of cononical forms of binary quantics of odd order.

The "Elements of Physics" by E. L. Nichols and W. S. Franklin, issuing from the press of the Macmillan Company, has reached its third and final volume. Vol. I treating of Mechanics and Heat and Vol. II on Electricity have already been noticed in these pages. Vol. III deals with Light and Sound, the two allied departments of Physics in which the phenomena find their explanation in the properties of wave motion.

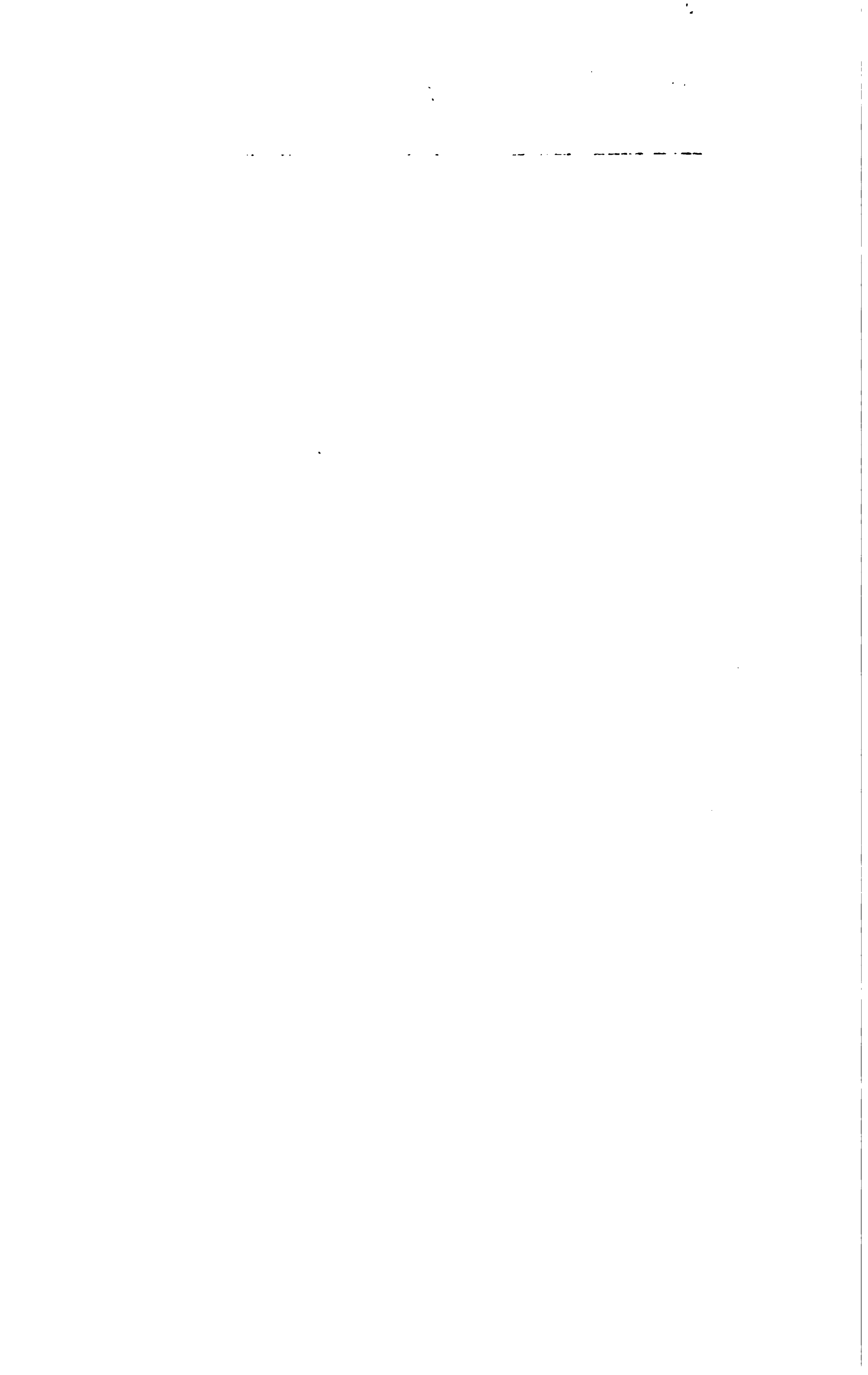
Accordingly Vol. III opens with a mathematical discussion of wave motion. The authors have wisely given this discussion a geometric rather than an analytic form; wisely because of the fact that analytic formulæ are often handled with ease by the student and yet they convey to him very imperfect conceptions of the physical phenomena they are intended to represent. This is because the formulæ are imperfectly interpreted; in other words the language of analysis, however elegant, is badly translated into the vernacular of familiar ideas. The results of analysis are never realized in the mind of the student until they are graphically presented either to the outward or the inward eye. Hence in Physics graphical methods when simple and direct are, pedagogically speaking, always to be preferred to analytical ones.

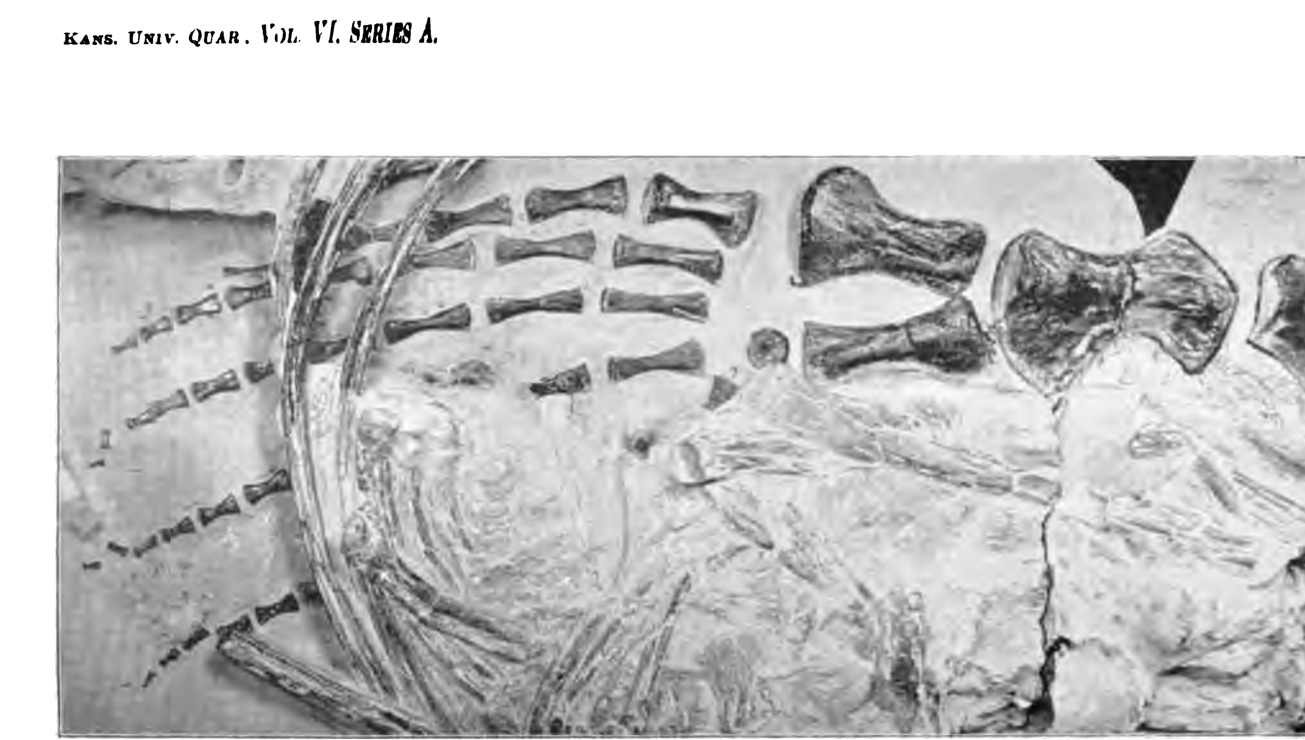
Herein lies the secret of much of the surpassing clearness of this volume on light and sound. An abundance of well drawn geometric figures serve to convey to the mind accurate images of the abstract ideas. When perfection in this method is reached we shall have the true royal road to knowledge. The writers of this textbook have produced a work that comes nearer to the above ideal than any similar work known to us. We doubt not but that this treatise on Physics will find a ready acceptance in such American colleges and universities as require of their students a working knowledge of calculus before admitting them to the courses in experimental and theoretical physics. H. B. N.


Fig. 1
I
II
III
IV
Fig. 2.
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
XIII



BRACHYSAURUS OVERTONI WILLISTON.





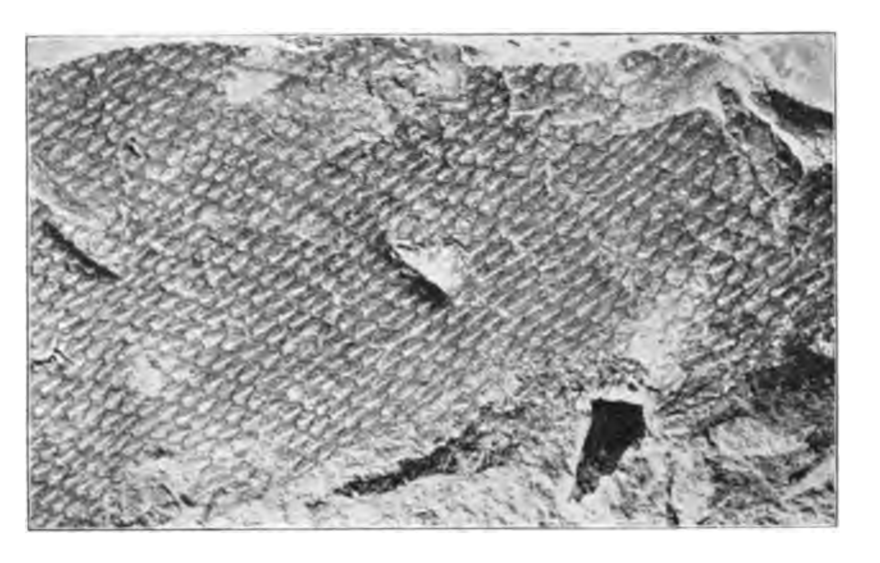
FRONT PADDLE OF TYLOSAURUS.



HIND PADDLE OF TYLOSAURUS.



PELVIS OF TYLOSAURUS.



SKIN OF TYLOSAURUS. Natural size.


BEN-HUR
TRADEMARK.
BICYCLES.

Vol. VI. JULY, 1897. No. 3.

THE KANSAS UNIVERSITY QUARTERLY.

SERIES A:—SCIENCE AND MATHEMATICS.

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KANSAS UNIVERSITY QUARTERLY

VOL. VI. JULY, 1897. NO. 3.

Restoration of Kansas Mosasaurs.

BY S. W. WILLISTON.

With Plate XIII.

In the present communication are given restorations of the three principal genera of Kansas Mosasaurs, based upon the material now in the University of Kansas Museum. A detailed description of this material is now in preparation to be shortly published as a volume of the University Geological Survey, of which Chancellor Snow is Director. At present only the more striking characters of the three forms will be discussed.

The three genera herewith given comprise all the authentic types known from Kansas. In addition, *Holosaurus* Marsh, *Sironectes* Cope and *Baptosaurus* Marsh, have been described from or accredited to the Cretaceous of the state. *Sironectes*, is, I believe, a synonym of *Platecarpus*. It was based upon the presence of the zygosphene in connection with free chevrons. In *Platecarpus* there is, in most species, a rudimentary zygosphene, and in some it is nearly as large as in some species of *Clidastes*. It is possible that *Holosaurus* is a good genus, but specimens of it must be exceedingly rare. The type specimen, now in the Yale Museum, was collected by myself and represents nearly the complete skeleton. *Baptosaurus* is practically known only from the posterior part of the jaw, described by Merriam. This is very peculiar in having the articular bone reflected upwards at the extremity.

The material upon which the restorations here given are based is as follows: *Clidastes* is restored from a single specimen, complete in all details, save the terminal phalanges of the front paddle and most of those of the hind paddles. The present restoration differs

from the one previously published only in the less flattened skull, and in the curvature of the digits.

Platecarpus is based chiefly upon one specimen, comprising a nearly complete disarticulated skull and a connected series of vertebræ to beyond the middle of the tail, the sixty-fifth, together with the pectoral and pelvic girdles and most of the bones of the limbs. The arrangement of these bones has been copied, from Marsh, with some changes. The only parts conjectural are the number of long ribs and the number of chevron-caudal vertebræ. Isolated bones and partly connected series of caudal vertebræ are preserved in other specimens, from which there seems to be very slight differences from the corresponding parts of *Tylosaurus*. The tail has, therefore, been made to correspond with that of *Tylosaurus* in length.

Tylosaurus is drawn from three specimens, one with the posterior part of the head and the vertebral column complete to the tip, the second with the skull and cervical vertebræ in perfect preservation, the third with the paddles nearly complete, together with the larger part of the vertebræ and ribs. This last specimen is the one of which figures of the paddles and skin were given by me in the last number of this journal. All of these specimens agree closely in size and characters, clearly belonging to the same species.

A comparison of these genera, as shown by the restorations, will be of interest. *Platecarpus* has an intermediate position between *Clidastes* and *Tylosaurus*, which represent the extremes of development of the Kansas forms. In *Clidastes* the thorax is elongate, the tail relatively short and modified into a powerful propelling organ. The limbs are small, the hind ones especially so. The animal throughout is more slender, and the head relatively short, agreeing in this respect more closely with their nearest modern relatives, the species of *Varanus*. The vertebræ have the firmest and closest articulations, with the interlocking zygosphene best developed of any of the Mosasaurs. The limbs are less flexible, but relatively stronger, as shown by the closely articulating bones and the fully developed carpus and tarsus, and the more pronounced processes for muscular attachment. The movement through the water in this form was more snake-like than in the others, and propulsion was largely by means of the tail.

In *Platecarpus* we have the same shortened muzzle as in *Clidastes*, the vertebræ also relatively slender, and the zygosphene imperfectly developed. The paddles are more of the *Clidastes* type than

that of the *Tylosaurus*, though the carpus and tarsus are less well developed than in the former. The hind paddles are only slightly smaller than the fore ones, and all are powerful propelling organs, far more so than in any other known genus of the group. Altogether, in proportion to its size, *Platecarpus* was the most powerful and predaceous of the Kansas Mosasaurs. It will be observed that the teeth in this form, while not as numerous as in *Clidastes*, or as stout as in *Tylosaurus*, are more effective weapons than in either of these genera, being more elongated, more curved and more pointed. The neural spines do not form as close a series as in *Tylosaurus*, indicating greater flexibility.

In *Tylosaurus* we have in some respects the most specialized of the Mosasaurs. The almost wholly cartilaginous carpus and tarsus, the more elongated digits and the greater number of the phalanges, are characters brought about by aquatic habits. On the other hand, the hind paddle is actually larger than the front, and the fifth digit has undergone little or no reduction, characters of a more primitive rank. The paddles are more flexible than in either of the other genera, but they are relatively small and not at all strong. The skull is more elongated anteriorly and there is no trace of a zygosphene.

Dr. Dollo has expressed a doubt of the nature of the vertebræ called pygial by Mr. Case and myself in a former publication. He believes that some of them at least are true lumbar vertebræ, as all were previously thought to be. I feel yet more assured that they are basal caudal and have so restored the different genera. In the living lizard, with the sacral synchondrosis, the ilium is directed forward, throwing the symphysis ischii below the sacrum and leaving the outlet of the pelvis unrestricted. In *Varanus* there are as few as two non-chevron-bearing vertebræ back of the sacrum. More were not needed. In these marine lizards, on the other hand, the shaft of the ilium is directed obliquely forward, bringing the symphysis of the ischii below the fourth or fifth of the vertebræ succeeding the ligamentous attachment. If these or any of them bore chevrons, it will be immediately seen that they would project into the cavity of the pelvis. Not less than six pygal vertebræ are necessary to leave space for the free exit of the cloaca. The ilium must have been in every case attached to the first non-costiferous vertebra.

In these three species the number of vertebræ in the different regions may be given as follows:

	Clidastes.	Platecarpus.	Tylosaurus.
Cervical	7	7	7
Thoracic	11	13?	13?
Lumbodorsal	24	9	10
Pygal caudals	7	5	6
Diapophysial caudals	25	15	25
Non-diapophysial caudals	45	?	55

The zygapophyses in all three forms terminate at or near the end of the rib-bearing vertebræ. In the cervical region they are strong, diminishing but little in size through the thoracic region. In the region which I call lumbodorsal, they become weaker. The vertebræ increase in length through the thoracic region, but diminish very rapidly in length at the end of the costiferous series.

The length of *Clidastes velox* is about twelve feet, that of *Platecarpus coryphæus* nearly fourteen, while *Tylosaurus proriger*, one of the smaller species of the genus, was over twenty-three feet. The smallest species of *Clidastes*, *C. pumilus*, if it be a distinct species, was about six feet in life. The largest species of the Kansas Mosasaurs, *Tylosaurus dyspelor* had a length of nearly thirty feet. Only one other species of the group larger than *Tylosaurus dyspelor* has been described from America—*Mosasaurus maximus* Marsh, from New Jersey. If it had the same proportions as *Tylosaurus* its length would be about thirty-two feet. If like *Clidastes*, as it was in all probability, its length would not exceed thirty-six feet. European forms somewhat larger than this have been described, possibly reaching a length of nearly forty feet. The text-books and popular descriptions place the length of these animals at from seventy-five to one hundred feet!

The food of the Mosasaurs must have consisted chiefly of fishes of moderate size with occasional victims of their own kind. While the flexibility and loose union of the jaws undoubtedly permitted animals of considerable size to be swallowed, the structure of the thoracic girdle would not have permitted any such feats of deglutition as the Python and Boa are capable of. The animals must have been practically helpless on land. They were not sufficiently serpentine to move about without the aid of the limbs, and these were not at all fitted for land locomotion. They lived in the open sea, often remote from the shores. Their pugnacity is amply indicated by the many scars and injuries they received, probably from others of their own kind.

Salicylic Acid and Calcium Sulfite as Preservatives of Cider.

BY E. H. S. BAILEY AND CHAS. M. PALMER.

The object of these experiments was to determine the preservative influence exerted upon cider (and hence other fermentable liquids), by salicylic acid and sulfurous acid, the latter being in the form of calcium sulfite, in various amounts; also to review the various methods of detecting these agents. The surrounding conditions were supposed to simulate those under which these substances are used by people generally, and considerable reference is also made to the literature of their use, effect, detection, etc.: especially in the case of salicylic acid.

Salicylic acid was discovered in 1838 by Piria (Amer. Jour. of Phar., Aug., 1843,), but it was not until Kolbe so improved the method of manufacture in 1874 (J. Prakt, Chem. 2, 10, '93,), as to render it commercially available that it was used as a preservative. He made an extensive study of its anti-fermentative action which extended over a year or two. His conclusions were that it restrained or prevented the action of organized ferments and also that of unorganized ferments to some extent, but that it was harmless to animal life, and he strongly advocated its use as a food preservative.

On August 7 and 8, 1882, at the Nuremberg meeting of the Independent Union of the Bavarian Representatives of Applied Chemistry, the association, after an exhaustive discussion of the propriety of the use of salicylic acid as a food preservative, refused, by a practically unanimous vote, to sanction its addition to beer (Bull. U. S. Dept. of Agric. 13, Pt. 8,). In Germany its use is prohibited, except in beers intended for exportation. In France its use in food or drink of any kind was forbidden by ministerial decree on the 7th of February, 1881.

In this country Dr. Cyrus Edson, of the New York board of health, seized, on November 11, 1886, 5,280 gallons of artificial

wine which had been preserved with salicylic acid. It contained about 4.5 grains to the pint. (Am. Analyst, 416, 1886.)

Very little can be inferred as to the physiological effects of the continued use of salicylic acid, as reliable experiments upon human subjects are rare. Kolbe took a daily dose of it for over a year, beginning with one-half gram and gradually increasing it to 1.5 grams without noticeable effect. Two workmen (Methoden der praktischen Hygiene, Wiesbaden, 1890, 281,) to each of whom .5 grams were administered daily for seventy-five and ninety-one days respectively, by Lehmann, experienced no injurious effect. A case is recorded in the Virginia Medical Monthly, of death in forty hours from 48 grains of salicylic acid—this quantity being taken within four hours.

Dr. Bartley (Am. Analyst, April 1, 1887,) is of the opinion that the use of salicylic acid, as a preservative for foods and beverages, should receive a check at the hands of the authorities.

A special committee of the Paris Academy of Medicine reported upon the uses of salicylic acid, that the injection of such small quantities as are liable to be found in food might result in no injury to persons in good health, but to the aged or those in feeble health injury might follow. Those affected with diseased kidneys or dyspepsia they found to be especially sensitive to its action (Bull. de l'Acad. de Med., Paris, 1886,). They recommend that its use, as a preservative of food, even in small amount be absolutely prohibited.

The various commercial articles sold as "Extract of Salix," "Preservaline," "Conservaline," "Antispoil," etc., are generally found to contain salicylic acid or other well known substances as borax, boric acid, benzoic acid, etc.

Salicylic acid admits of ready detection in very small quantities and in great dilution. The sensitiveness of the ferric chloride test has been placed as high as one part in 100000. Two c.c. of a 1-20000 solution of salicylic acid in cider was neutralized with sodium carbonate and evaporated to dryness and the residue extracted with dilute salfuric acid. This acid liquid was shaken out with chloroform, the latter separated and allowed to evaporate spontaneously. The residue gave a very distinct violet color with ferric chloride. The ferric chloride reaction is prevented by a number of substances in consequence of which the acid should be purified before applying the test. It may be separated by dialysis, shaking out with an immiscible solvent and distilling the residue with steam, etc.

Blas (Jour. Prackt. Chem. 19, 43,) and others (U. S. Bull. Dept. Agric. 13, part 3), recommend using the body as a means of separation and applying the test to the urine. This proved very efficient in the hands of the writers. Of eight methods tried by Crampton and his fellow assistants (U. S. Bull. 13, part 3), extraction with equal parts of ethylic and petroleum ether, and extraction with ether, spontaneous evaporation and again extracting with benzine, were the two which gave decidedly the best results in working with beer. The writers found chloroform to give the best results with cider, used as above described.

There is no dearth of qualitative tests, but an easy and satisfactory method for the quantitative determination is yet wanting. The qualitative methods of extraction may be made complete and the pure crystallized acid weighed or dissolved in alcohol and titrated with a soda solution standardized with a like solution of salicylic acid of known strength. Colorimetric methods have also been proposed by Dr. Muter (Analysist 1, 193; Remont, Jour. of Pharm. Chem, (5), 4, 34; Chem. Cent. 1881, 773), and modifications of the last by Pellet and DeGrobert (Compt. Rend. 93, 278; Chem. Cent. 1881, 711). The last three references are from the U. S. Bull. Dept. Agric. 13, part 3.

In regard to the efficiency of the preservative action of salicylic acid, Dr. A. B. Griffiths (Chem. News, 53, p. 28) placed a drop of yeast on a slide under the microscope and then ran a few drops of salicylic acid solution, 1-5000, between the cover and slide and found it to have no action upon the true alcoholic ferment—Torula. But by treating in the same manner mounts of mycoderma aceti, bacterium lactis and the buteric bacillus, these ferments were quickly destroyed. He observed that the acid solution acted chemically upon the substance of the cell wall, in some cases causing perforation. He found also that the above solution of salicylic acid prevented yeast from converting cane sugar into dextrose and levulose, and also the action of ptyalin on starch. The experiments of the writers would seem to lead to different conclusions, at least concerning the Torula and Micoderma.

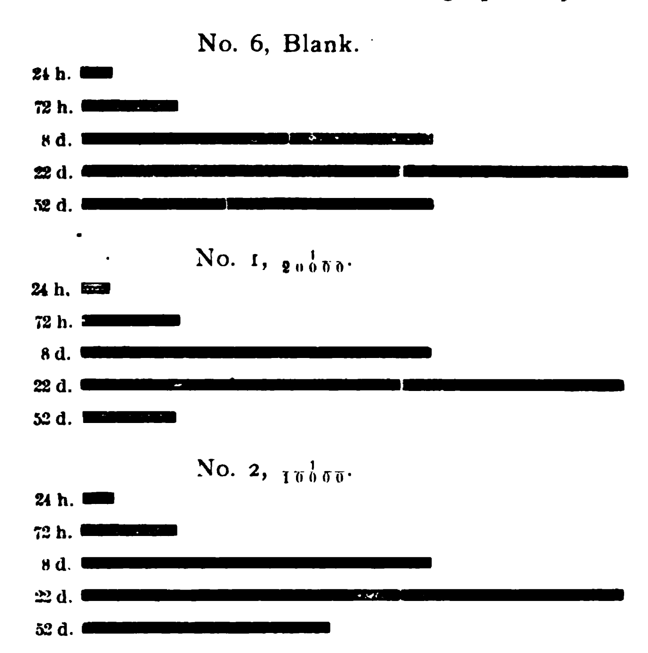
Six flasks, containing cider, were protected from dust by placing watch glasses over their mouths and set aside under ordinary atmospheric conditions and at temperatures ranging from 12 to 22 C. (53.6, in 71.6 F.). No. 1 contained 1-20000 of salicylic acid, No. 2 1-1000, No. 3 1-5000, No. 4 1-1000, No. 5 1-500, No. 6 and 6 (a) were blanks. The cider was fresh and contained .2 per cent of alcohol. Distillations were made in twenty-four hours, seventy-

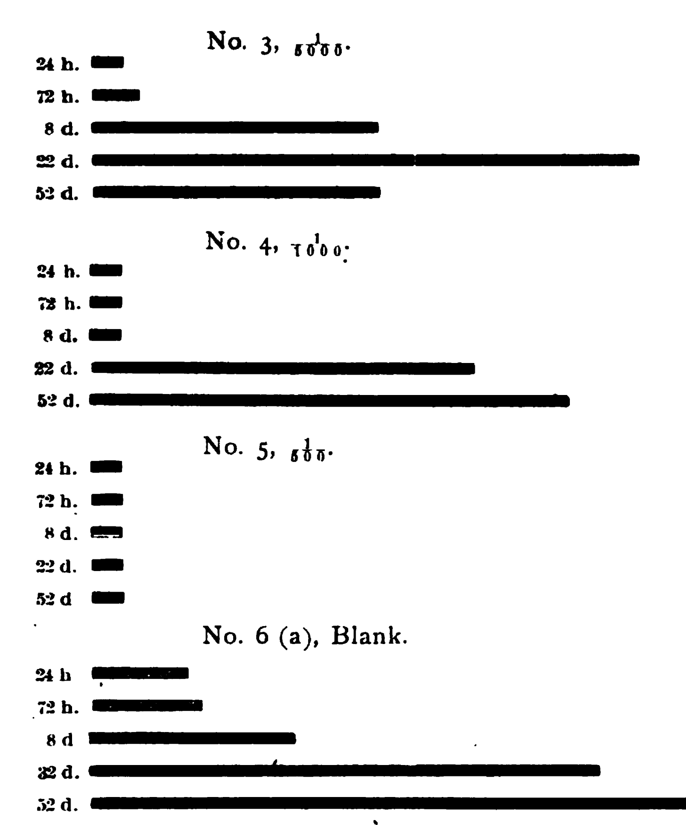
two hours, eight days, twenty-four days, and fifty-two days with the results as stated in table 1, below. Nos. 4, 5 and 6 (a) were started later with five other samples, and contained about 1-20000 of salicylic acid which had been added by the enterprising cider vender. At the last series of distillations titrations were made and the results given as acetic acid. Titrations, the results of which are given, were also made two months after the last distillations.

TABLE 1.

	PER CENT OF ALCOHOL.					P. C. OF ACETIC ACID.	
Interval. ☞	24 h.	72 h.	8 d.	22 d.	52 d.	52 days.	112 days.
Strength.							
No. 6, blank...	0.3	1.0	3.3	5.9	3.2	3.6	7.38
No. 1, 1-20000.	0.3	0.8	3.2	5.9	1.5	5.8	7.38
No. 2, 1-10000.	0.3	0.7	3.2	6.0	2.3	5.	7.87
No. 3, 1-5000..	0.3	0.5	2.7	6.0	2.6	4.7	7.79
No. 4, 1-1000...	0.3	0.3	0.3	4.0	4.8	0.4	0.4
No. 5, 1-500...	0.3	0.3	0.3	0.4	0.4	0.58	0.6
No. 6 (a) blank	1.0	1.2	2.3	5.3	6.3	1.6	3.48

These results are better shown graphically thus:





Though the effect of the preservative is not very marked till a $\frac{1}{1000}$ solution is used, yet it seems that 1-5000 solution of salicylic acid does have a noticeable effect upon the alcoholic ferments and the micoderma seems to do very well in a 1-1000 solution. But in the end it is probable that the maximum amount of both alcohol and acetic acid are produced, as the last distillations and titrations indicate in the case of Nos. 1, 2, 3, and 6. Attention might be called to the fact that 6 per cent of alcohol would theoretically yield respectively 7.8 per cent and 7.3 per cent of acetic acid.

There seems to be considerably less literature upon the use of sulfurous acid or its salts as preservatives, although it has long been known as an agent very destructive to bacterial life. Its detection in small quantity in the presence of organic matter is difficult, since it has been concluded that hydrogen sulfid is produced by zinc and hydrochloric acid with albuminous compounds or any compounds containing sulfur (U. S. Bull. 13, part 3,). But in quantities sufficient to exert any preservative influence sulfurous

acid may be readily detected by zinc and HCl, as about 1 c.c. of a 2 2000 solution of calcium sulfite in cider when treated with a few scraps of zinc and about six c.c. of concentrated HCl, promptly gave the unmistakable odor of hydrogen sulfid and darkened lead acetate paper in less than one minute.

Neither HCl nor H_2SO_4 in 1-4000 and 1-2000 solutions in cider gave evidence of SO_2, but 1-1000, 1-500 and 1-250 solutions gave a somewhat pungent odor; none of them, however, produced a color with mercurous nitrate paper (paper saturated with mercurous nitrate solution). Potassium bichromate was not sensibly reduced by thc amounts present in the above solutions, but the 1-250 solution gave an olive green color, not characteristic. Sodium nitroprusside gave no results whatever.

Quantitative determinations were not attempted, but for those interested reference might be made to the method in use by the Union of Baverian Chemists, described in U. S. Bull. 13, page 3. It consists in acidulating with phosphoric acid, distilling in a current of CO_2 then collecting in a solution of iodine. The sulfuric acid formed is then estimated in the usual way as barium sulfate.

Table 2 shows the effect of various amounts of calcium sulfite upon cider treated in the same manner as those previously mentioned. One more distillation was made of each sample and titrations were calculated as acetic acid as before, although in all probability the acidity in Nos. 1, 2, 3, and 4, was wholly due to the malic acid of the fruit.

TABLE 2.

PER CENT OF ALCOHOL.							PER CENT OF ACETIC ACID.	
Interval. ☛	24 h.	72 h.	8 d.	22 d.	52 d.	112 d	52 d.	112 d.
Strength.								
Nc. 1, 1-250...	0.3	0.3	0.2	0.6	0.4	3.9	0.57	0.41
No. 2, 1-500...	0.3	0.3	0.3	0.3	5.4	3.9	0.48	0.41
No. 3, 1-1000..	0.3	0.3	0.3	3.9	6.1	3.9	0.41	0.41
No. 4, 1-2000..	0.3	0.4	0.9	4.8	6.3	4.0	0.41	0.41
No. 5, 1-4000 .	0.3	0.6	1.5	5.0	6.2	2.2	0.41	3.0
No. 6, blank...	1.0	1.2	2.3	5.3	6.3	2.2	1.62	3.48

This sample contained 0.3 per cent of alcohol at the beginning.

Here the effect of the increasing quantity of the preservative is very plainly shown, and even a $\frac{1}{4000}$ solution has a noticeable effect. The action of the sulfite seems to be retarding only, for considerable alcohol is produced after the fifty-second day, even in a $\frac{1}{250}$ solution. The formation of acetic acid is much retarded.

On the Composition of the Louisville Mineral Water.

BY E. H. S. BAILEY.

In Pottawatomie county, three miles north of Wamego, near Louisville, the former county seat, is a mineral spring that has attracted considerable attention locally, but a complete analysis of its water has never been published. The spring is situated beside a small stream that flows into Rock creek at this point. The surroundings, a natural park of oak and walnut, ash and elm, add much to the attractiveness of the place. The park is connected with the village by a suspension foot bridge over Rock creek. Just below this bridge a dam has been thrown across the stream, to supply the mill near by with water power; and the swift stream below the dam, at the "ford" on the old Pike's Peak trail has washed bare the level limestone rock over a large area. This same stratum of rock that is here exposed, extends north and west under the park and the spring.

The spring has recently been made more accessible by sinking over it a tile twenty-four inches in diameter, down to the bed-rock, through a cleft in which the spring water rises, and the water can be raised to the platform above by means of a pump.

The temperature of the spring, in May was 56° F. On July 7 it was the same. In the winter the temperature changes very little. The amount of water that flows is generally sufficient to fill an inch pipe. Although the water when first drawn is perfectly clear and transparent, in a very short time it becomes yellow and turbid. Boiling the water also causes a heavy precipitate to deposit. The taste of the water is somewhat astringent, and there is sometimes a slight odor of hydrogen sulfide from the spring. The The water when evaporated has a slight alkaline reaction.

The analysis of a sample of the water taken from the spring May 17 shows that 100.000 parts of the water contain the following constituents:

$Si\,O_2$ and insoluble residue	4.64
$Fe_2\,O_3$	2.84
Ca O	38.17
Mg O	9.32
$Na_2\,O$	8.05
$K_2\,O$	0.52
$S\,O_3$	12.89
Cl	3.85
$C\,O_2$	99.90
$N_2\,O_3$	a trace.
Organic matter	a trace.

The most probable combination for the above constituents would be as follows:

Silica and insoluble residue,	$(Si\,O_2)$	4.64
Iron bicarbonate,	$(Fe\,H_2\,[C\,O_3]_2)$	6.32
Calcicum bicarbonate,	$(Ca\,H_2\,[C\,O_3]_2)$	94.65
Magnesium "	$(Mg\,H_2\,[C\,O_3]_2)$	33.93
Sodium "	$(Na\,H\,C\,O_3)$	1.93
Calcium sulfate,	$(Ca\,S\,O_4)$	13.24
Sodium "	$(Na_2\,S\,O_4)$	9.06
Potassium "	$(K_2\,S\,O_4)$	0.96
Sodium chloride,	(Na Cl)	6.36
Sodium nitrate,	$(Na\,N\,O_3)$	a trace.
Total		171.09

Free carbonic acid gas, 23.91.

This may be express in grains per U. S. gallon of 231 cubic inches, a common method of expression, as follows:

Silica and insoluble residue	2.706 grains
Iron bicarbonate	3.685 grains
Calcicum bicarbonate	55.198 grains
Magnesium bicarbonate	19.787 grains
Sodium bicarbonate	1.125 grains
Calcicum sulfate	7.721 grains
Sodium sulfate	5,284 grains
Potassium sulfate	0.560 grains
Sodium chloride	3.709 grains
Sodium nitrate	a trace.
Total	99.775 grains

Free carbonic acid gas, abundant.

The analysis shows that the water is a chalybeate and also

belongs to the class known as alkaline water. From a medicinal standpoint, its most important ingredients are, no doubt, the magnesium bi-carbonate, the iron bi-carbonate and the sodium sulafte. There are numerous waters in the state that contain more magnesium salts than this spring, but very often these are mixed with a large quantity of sodium chloride, so that the water is really a brine and hence cannot be used as a beverage.

Iron is held in solution by the excess of carbonic acid gas, so that soon after the water is drawn this gas has an opportunity to escape and the iron is oxidized and separates out as a yellowish powder, and some of the lime carbonate is frequently deposited with it. The water is therefore not adapted to shipping away from the spring, though possibly, if thoroughly charged with carbonic acid gas and kept under pressure, this might be done.

The quantity of mineral matter is not very large; many of our springs and some rivers contain more. The Saline river, for instance, contains twice as much mineral matter in solution as this spring, but in this river about half of the mineral matter is common salt. The Solomon river contains nearly as much mineral matter as the Louisville spring, but here, too, there is about forty per cent. salt. The water analyzed is decidedly "hard" on account of the large quantity of calcium carbonate (lime) held in solution, but that would be naturally expected where water flows through limestone strata as in this case.

Myology of the Hind Limb of the Raccoon.

(*Procyon lotor.*)

BY R. C. GOWELL.

With Plates XIV, XV, and XVI.

This paper was suggested on noting how much certain muscles in specimens of the Raccoon dissected by the author differed from the description by Dr. Harrison Allen. (The Muscles of the Limbs of the Raccoon, *Procyon lotor*, by Harrison Allen, M. D., Proc. Acad. Nat. Sci. of Phila., 1882, pp. 115-144.) These variations are of special interest since they occur in a generalized species of low intelligence, whose individuals differ little in habits, and among which we should expect little variation in structure. Dr. Allen's descriptions were based upon dissections of two female raccoons which had probably been in captivity. This may have changed the proportions of certain muscles, but certainly not their attachments. My specimens differed little among themselves and seemed to present a normal structure judging from other carnivorous animals; while in some cases Dr. Allen's arrangement would be very remarkable.

If errors exist in Dr. Allen's work they may safely be attributed to oversight or lack of material. Errors are prone to occur where everything depends upon accurate dissection and observation, and although much care has been taken in the preparation of this paper the author cannot hope that all errors have been avoided.

The material upon which this paper is based consists of an adult female raccoon and two very large males. These specimens were procured through the kindness of Mr. J. C. Saunders of Lawrence. In most instances only such muscles are considered as seem to present variation or other interesting features.

Biceps femoris; Plate XIV, Bic.; Plate XVI, Fig. 7.

I found the arrangement of the biceps femoris to be as follows: It arises from the lateral aspect of the tuberosity of the ischium and, spreading over the lateral surface of the thigh, is inserted by aponeurosis from the middle of the thigh half way to the heel; that

is, into the fascia lata, lateral margin of patella, ligamentum patellæ, especially into anterior spine of tibia, and below into anterior fascia of the leg. From the deep surface of the biceps near its insertion a strong aponeurosis passes beneath the tenuissimus to join the gastrocnemius at its lower third, but the fibers may be traced to the heel. From Dr. Allen's description it appears that with the exception of the slip to the soleus, he found the insertion entirely on the patella and head of tibia, it being much more restricted than in my specimens. The aponeurosis passing to the gastrocnemius probably corresponds to the "slender fascicle" described by Dr. Allen and, if so, does not differ greatly. The origin by "stout aponeurosis from the spine of the sacrum" was not present in any of my specimens. Sacrum may be a misprint for ischium, for I found no origin from the spine of this bone. The division of the ischial origin into two portions, in Dr. Allen's variation, was evident in all of the specimens examined, but the parts soon joined.

Tenuissimus; Plate XIV, Ten.

The muscle is better developed than in the cat. It arises from the deep surface of the gluteus maximus and passes to the caudal border of the biceps, along the lower fourth of which it descends to be inserted into the fascia of the leg below the biceps. In one of the males the posterior border of the muscle received at the distal third a thin strip from the caudo-tibial division of the semitendinosus. This muscle, owing to its advantageous insertion, materially aids in flexing the leg upon the thigh.

Semitendinosus; Plate XIV, St., Stc.; Plate XV. St.; Plate XVI, Figs. 6 and 8, St.

The semitendinosus arises from the postero-lateral portion of the tuberosity of the ischium and from caudal vertebræ. The ischial origin envelopes the origin of the biceps behind and is slightly joined to that muscle for a short distance. The caudal origin is from the transverse processes of the first two caudal vertebræ. The origin from the first is in common with the caudal origin of the gluteus maximus and is not as extensive as that from the second. This caudal portion passes over the biceps and along the anterior border of the ischial part which it joins at the middle third. In one specimen a delicate fascicle passed from the middle of the semitendinosus to the tenuissimus (see plate XIV). The insertion, which is by flat tendon into the middle of the tibial crest and by fascia into the mesal surface of the tibia, underlies the aponeurotic part of the insertion of the gracilis. Dr. Allen found

no vertebral origin of the semitendinosus, nor did I find the origin to be in part by a fleshy slip from the biceps.

Semimembranosus; Plates XIV and XV, Sm.; Plate XVI, Figs. 1, 4, 6 and 8, Sm.

This muscle presents little variation. The "long fusiform slip" uniting the two parts, is so closely joined to the "ischio-pubio-femoral" part throughout that it may be easily overlooked. This slip arises from the ischium between the origin of the other parts.

Sartorius; Plate XV, Sart.; Plate XVI, Figs. 6 and 8, Sar.

The sartorius presents a much less extensive insertion than indicated by Dr. Allen. In no case did I find the insertion extending more than an inch below the head of the tibia, that is not more than one-fifth the length of that bone, at which point the insertion of the gracilis began.

Gracilis; Plate XV, Grac.; Plate XVI, Figs. 6 and 8, Gr.

The gracilis is a broad thin muscle covering the posterior half of the mesal surface of the thigh. It arises muscularly from the whole length of the symphysis pubis, from the descending ramus of the pubis and membranously for an inch, in the female half an inch, in front of the symphysis. In one of the males there was no origin from the descending ramus of the pubis. The insertion is coterminous to the insertion of the sartorius and in the same plane, it extends to about the middle of the tibia. The upper part of the insertion is by a strong direct tendon five-eighths of an inch broad, the remainder consists of oblique fibers, from the caudal border of this muscle, which overlie the insertion of the semitendinosus. According to Dr. Allen's description this muscle must have been very different in his specimens. (See p. 135 of his paper.)

Adductor magnus; Plates XIV and XV, A. M.; Plate XVI, Figs. 1, 3 and 4, A. M.

The adductor magnus was entirely free from the gracilis, instead of taking origin in part from the deep surface thereof. The insertion occupies not only the lower half of the posterior surface of the femur, but also a narrow strip extending up to the gluteal ridge.

Pectineus and Adductor brevis; Plate XV, Pect. and A. Br.; Plate XVI, Figs. 1 and 4, P. and A. B.

These muscles, inseparably united, arise from the ilio-pectineal line as stated by Dr. Allen. In all of my specimens, however, the pectineus and adductor brevis were inserted, not upon the adductor longus but upon the femur, by a well defined line *mesal* to the insertion of the adductor longus. This line began at the lesser

trochanter just mesal to the insertion of the quadratus femoris and, bowing outward, extended to the middle of the femur; thus the insertion is well separated, especially proximally, from the adductor longus.

Vastus externus; Plate XVI. Figs. 2 and 3, V. E.

This muscle is much larger than the vastus internus. It arises from the upper half of the shaft of the femur from the antero-lateral surface, including the anterior surface of the great trochanter. The muscle is tendinous superficially above, and the deep surface fuses with the crureus. The muscular fibers converge to the lateral margin of the patella and to the lower fourth of the rectus femoris.

Crureus; Plate XVI, Figs. 2, 3 and 4, Cru.

This muscle is much connected with the vasti, but is, perhaps, worthy of individual description. It arises from the anterior surface of the femur; the area of origin is an irregular triangle, whose concave base extends between the supracondylar ridges an inch from the condyles. The origin extends above the middle of the shaft and is coterminous proximally with the vastus internus and laterally with the vastus externus. The insertion is into the capsular ligament of the knee and the summit and sides of the patella. Although this muscle arises from a large surface it is the smallest of the extensor group.

Soleus; Plates XIV and XV, Sol.; Plate XVI, Figs. 5 and 8, Sol.

I found the soleus to be of medium size, rather flat and narrow, being a little more than an inch in breadth in the male raccoons and smaller in the female. It was smaller than either head of the gastrocnemius, and, of course, much smaller than the whole muscle. In one of the males the lateral edge of the soleus was fibrous and fused with the tendo-Achillis and slip from the biceps for two inches above the os calcis. In the other specimens this muscle was free to its insertion upon the tendo-Achillis just above the heel.

Flexor longus digitorum; Plate XV, F. L. D.; Plate XVI, Figs. 5 and8, F L. D.

Besides arising from a narrow strip occupying the proximal half or two-thirds of the posterior surface of the tibia, this muscle presents an origin from the head of the fibula. The slip from this origin passes over the tibialis posticus to join the tibial portion.

The *accessory slips* from the long to the short flexors (Plate XV, M. S.) presented a variation. Instead of being inserted upon the short flexor slips to the first, second and third toes they were in-

serted, one on the slip to the third and two on the slip to the fourth toe. This arrangement was constant, the little slips presenting no variation in number or proportions. The two to the tendon of the fourth toe were inserted about one-fourth of an inch apart.

Tibialis posticus; Plate XVI, Figs. 5 and 8, T. P.

The Tibialis posticus arises from the proximal ends of the tibia and fibula, as stated by Dr. Allen, but the origin from the tibia extends over half way down the shaft, lying just laterad to the origin of the flexor longus digitorum with which it is closely connected. This muscle also arises largely from adjoining fascia, especially of the flexor longus hallucis. Its tendon is wholly concealed by the flexor longus digitorum, in company with which it passes through a sheath behind the internal malleolus, but in a separate compartment, and is inserted on the plantar surface of the scaphoid.

Peroneus longus; Plate XIV, Per. lon.; Plate XVI, Figs. 5 and 7, P. l.

The insertion of this muscle, as given by Dr. Allen, is very different from what I found. (See p. 139 of his paper.) In my specimens the carneous fibers converge to a round tendon. This tendon passes through a sheath behind the highest tubercle on the external malleolus, and superficial to the tendons of the other peroneals, to a loop behind the prominent tubercle on the anterior part of the lateral surface of the os calcis. From this point its direction corresponds to the long axis of the foot, until it enters the deep groove in the anterior part of the plantar surface of the cuboid, thence the tendon passes obliquely across the foot to be inserted into the outside of the base of the first metatarsal. This insertion of the peroneus longus is practically the same as is found in man and the cat, and did not vary in the specimens examined by the author.

Peroneus brevis; Plate XIV, Per. Brev.; Plate XVI, Figs. 5, 6 and 7, P. Br.

The origin of this muscle occupies not only the middle third of the fibula but extends nearly to the malleolus. The tendon of insertion appears on the lateral surface of the muscle an inch below the origin, but receives carneous fibers down to the external malleolus, where, thick and strong, it passes through a deep groove on the posterior surface, thence beneath the peroneus longus, to be inserted into the lateral aspect of the base of the fifth metatarsal; and in some cases into the dorsal and plantar fascia.

Peroneus tertius: Plate XIV, Per. Ter.; Plate XVI, Figs. 5 and 7, P. T.

The peroneus tertius was not inserted upon the base of the fifth

metatarsal but upon the fifth digit at the bases of the first two phalanges, into the outside of the first and dorsum of the second. In one specimen a small slip passed to the division of the extensor brevis for the fourth toe.

Extensor longus hallucis; Plate XIV, E. L. H.; Plate XVI, Fig. 6, E. L. H.

Dr. Allen says: "This muscle was found in one subject only. It arises from the fibula at its upper third." This muscle was present in all of my specimens. It arose from the fibula for an inch, coterminously with the fibula origin of the tibialis anticus. Passing down behind the tibialis anticus it entered the loop with that muscle, and, becoming tendinous, wound around to the dorsum of the tibialis tendon where it gave a thin slip to be inserted with the same, then passed to the dorsum of the first phalanx of the hallux. In some cases this muscle was inserted entirely with the tibialis anticus and into adjacent fascia, no part going to the hallux.

Extensor brevis digitorum: Plate XIV, E. B. D.

This muscle consisted of five parts, which were distributed to the four inner toes. The slip to the hallux was inserted into the first phalanx, outside the extensor longus hallucis. The second toe received two slips, which were inserted on the dorsum of the second phalanx, in two instances side by side, in the other on each side of the long extensor tendon. The remaining slips were inserted on the third and fourth toes, outside the long extensor. The position of a short extensor to the fifth toe is occupied by the peroneus tertius.

Lumbricales; Plate XV, Lum.

The lumbricales vary in number. In one male Raccoon there were three, as found by Dr. Allen, but instead of being inserted upon the second, third and fourth toes, they went to the third, fourth and fifth toes. The insertion was upon the mesal side near the base of the first phalanx of each. Some of the tendons could be traced to the bone, others were lost on the sheaths of the flexor tendons. In the other specimens lumbricales passed to the four outer toes. These muscles arose at the divergence of the long flexor tendons, each muscle arising principally from the tendon to its toe. The muscle to the second toe was most slender, that to the fifth shortest and thickest.

Abductor minimi digiti; Plates XIV and XV, A. M.

This muscle arises from the plantar and mesal surface of the os calcis, just anterior to the insertion of the tendo-Achillis. The muscle is thin and flat, overlies the musculus accesorius, and tapers to its insertion at the base of the fifth metatarsal. The abdutor minimi digiti is not described by Dr. Allen.

Notes on the Osteology of Bison Antiquus Leidy.

BY ALBAN STEWART.

With Plate XVII.

Bison antiquus was first made known by Leidy, who described fragmentary remains of a horn core and frontal bone found at Big Bone Lick, Kentucky. His description is as follows: "The specimen is rather too small (a fragment) to determine positively whether or not it is a distinct species from *Bison latifrons*. It did not belong to an aged individual, as the suture is still open between the frontal bone and that portion of the parietal which forms the upper boundry of the temporal fossa. It belongs to a species of Bison, as indicated by the advanced position of the horn-core, and resembles more the corresponding part in *Bison priscus* of Europe, as represented by Cuvier and others, than it does that of *Bison latifrons*. The horn-core is more abruptly conoidal, and relatively more curved than in the latter. It is not improbable, however, that the fragment may have belonged to the female of *Bison latifrons*."

Since the above description was published additional remains have proved conclusively that *Bison antiquus* and *Bison latifrons* are two separate and distinct species. Below are given the cranial measurements of *Bison antiquus*, *Bison latifrons*, and the specimen in the Kansas University Museum, from which the following description is made:

	Bison antiquus.	Bison latifrons.	Kan. Univ. specimen.
*Distance from mesial plane of occiput to tip of either horn-core	360-470		457
Distance between tips of horn-cores	680-920	1932	875
Distance between bases of horn-cores	295-392	407-430	405
Least width of forehead (between orbits and horn-cores)	290-336	380	346
Greatest width of occiput	· 332	......	270
Circumference of horn-core at base	300-370	510-520	310
Fronto-nasal suture to occipital crest	343	......	269
Distance between edges of orbits	420	......	346

*The measurements of *Bison antiquus* and *Bison latifrons* were taken from The American Bisons, Allen.

Before entering into the description it would be well to give a short resume of the history of this animal as given by Allen.*

The type specimen from Big Bone Lick, Kentucky, seems to have been the only remains of this animal found in that locality, although remains belonging to *Bison americanus* have been found there in abundance—Prof. N. S. Shaler, in 1869, having collected something over a thousand specimens from this locality.

In 1860 Dr. Leidy figured and described a second premolar tooth from South Carolina.†

This specimen may belong to this species or to *Bison latifrons*. The atlas, fragmentary humerus, tibia and metatarsal bone from Darien, Georgia, are hardly sufficient to determine accurately to what species this material may belong, but from the description and measurements it would seem that it belongs to *Bison antiquus*. Below are given the comparative measurements of the two specimens:

ATLAS.

	Darien specimen.	Kas. Univ. specimen.
Transverse axis of brim of articular cup	133	139
Sterno-dorsal axis of cup	70	68
Transverse axis of post articular surface	136	128
Greatest transverse breadth of atlas	240	232
Greatest ventro-dorsal breadth of distal end	100	99
Greatest length near the lateral edge of wing	127	118
Length of centrum, dorsal aspect	84	70
Length of centrum, ventral aspect	59	60

METATARSAL.

	Darien specimen.	Kas. Univ. specimen.
Greatest length	264	270
Greatest transverse diameter of proximal end	65	68
Greatest antero-posterior diameter of proximal end	62	64.5
Transverse diameter of shaft 3.5 in. from proximal end	44	45
Antero-posterior diameter of shaft 3.5 in. from proximal end	44	44.5
Circumference of shaft 3.5 in. from proximal end	145	144

The above remains, with those in the museum here and one skull, now in the possession of a high school in Illinois, and of which a cut of the posterior view is given from a photograph furnished through the kindness of Mr. W. L. Brayton, are all the remains of this species that I know of as having been found east of the Rocky Mountains.‡

Abundance of these remains have been found in Alaska from Eschholtz Bay and the valley and tributaries of the Yukon river,

*The American Bisons, Living and Extinct.
†Holmes' Post-Pliocene Fossils of South Carolina, p. 109, pl. xxii.
‡I have recently examined a portion of a cranium of this species found on the upper part of the Saline river in Kansas.—S. W. Williston.

two collections having been made from the first of these localities and described by Sir John Richardson in the Zoology of the Voyage of the Herald. Some of these remains had not entirely lost their animal matter, the horns still covering the horn-cores in some instances. The second of these localities has furnished fragmentary remains of bison, represented in the collections of the National Museum and the California Academy of Sciences. The remains are more or less abundant in these localities, as miners often bring down horn-cores and other fragments when coming from the interior. In California the remains have been found in various places, associated with the bones of *Mastodon*, *Elephas*, *Tapirus*, and *Equus*. In Oregon a specimen of a phalangeal bone was described by Dr. Perkins, which probably belongs to this species.

From the above it may be seen that remains of *Bison antiquus* have been found in Georgia, South Carolina,(?) Kentucky, California, Oregon, Kansas, and Alaska, showing that the animal had a range over the greater part of North America. It was cotemporary with the Mammoth, Mastodon, and with man, as a small but well fashioned arrow-head was found by Mr. H. T. Martin, associated with the specimen now in the Kansas University Museum.

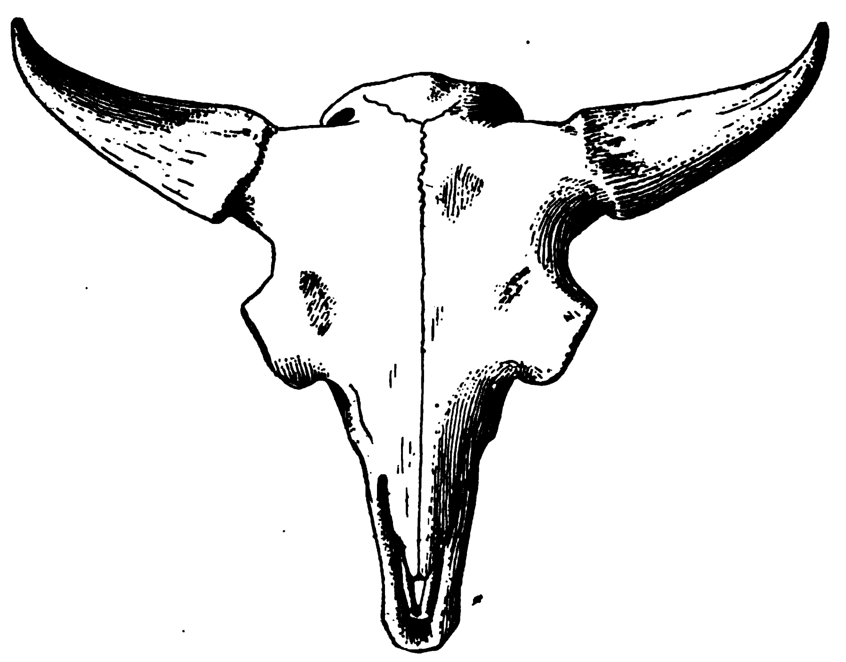
Skull.

The skull, when compared with *Bison americanus* and *Bos taurus*, presents numerous points of difference. The skull as a whole is much larger and more tapering toward the extremity, the horn-cores are proportionally longer, larger and less recurved than in *Bison americanus*, the orbits are more protruding and the pre-maxillæ are longer and narrower. Examined in detail the following points of difference are noted:

Occipital.

All of the occipital elements have become united in this specimen, forming one bone. The ex- and supra-occipitals form the back wall of the cranium, and when compared with the two recent forms mentioned above, many points of difference are observed. It is broader and proportionally lower than in either of the recent forms, and the two lateral halves are separated by a median carina which is present in the recent *Bos*, but not so well marked as in this species. This carina ends superiorly in a rugose-like swelling, which is much more prominent than in *Bison americanus*, for the attachment of the ligamentum nuchæ. The two lateral halves, instead of being nearly flat as in *Bos taurus*, are

quite deeply concave and the lambdoid crest is overhanging the occiput, a character not found in *Bos*. The ex-occipital element is strongly convex just above the condyles. The condyles are more obliquely set than in *Bison americanus*, and although the animal was much larger in every respect, yet the size of the foramen magnum is proportionally less than in the recent bison. The inter-condyloid notch is also proportionally broader in the recent form, the articular portions are regularly convex, the superior and inferior portions of each condyle insensibly grading into each other without being separated by the sharp ridge found at this point in *Bos taurus*. The basilar portion is more horizontally situated, and does not have the rugose knob-like projections just anterior to the condyles, so prominently marked as in *Bison americanus*. The par-occipital processes are firmly co-ossified with the mastoid portion of the periotic, are proportionally more slender and directed more inward than in either of recent forms mentioned above, and the external border is not so sharp as in *Bos taurus*.



Skull of *Bison antiquus*, front view.

Sphenoid.

The basi-sphenoid is shorter and more tapering than the basi-occipital; from the point of junction with this bone it is directed forward, but not so sharply upward as in *Bison americanus*. The

pre-sphenoid portion is not so sharply keeled as in *Bos taurus*, nor is the deep sharp groove, just posterior to this portion, so prominent as in the species just mentioned. The orbito- and alisphenoids are not sufficiently well preserved to determine their characters or give comparisons with the recent forms.

Periotic.

The mastoid portion is broad and wedged in between the squamosals and ex-occipitals as in both of the recent forms mentioned. The superior portion, which forms the floor of the temporal fossa, is directed more outward than in *Bison americanus*, and the ridge, which extends along the external border and represents the lower continuation of the lambdoid crest, is not so sharp as in the recent ox, but is more rounded and roughened for ligamentary attachment as in *Bison americanus*. The tubercle, just above the meatus auditorus externus, which is so prominent in *Bos*, has become much less marked and is somewhat roughened as in the recent bison. The anterior portion, just external to the glenoid cavity, is much more concave, but does not project downward so strongly as in *Bos*, nor does the internal portion project outward to form a pit for the hyoid bone.

The tympanic is much inflated from before backward and is more closely applied to the basi-occipital than in *Bos*, causing the external openings of the carotid canal and lacerated foramen to be very much compressed. The anterior styliform process is very short, even more so than in *Bison americanus*.

Squamosal.

So far as can be determined the squamosals are very similar to the corresponding portions of the two species with which it was compared, except that the glenoid cavity is not so flat and the post-glenoid foramen is more laterally situated than in *Bos*.

Jugal.

The posterior portions of the jugals are not preserved, but they were probably long and slender and extended almost to the glenoid cavity as in both of the recent forms. The anterior orbital portion is more strongly projected outward and overhanging the face than in either of the forms mentioned, and the rim is much roughened for muscular attachment. The infra-orbital ridge, which is so well marked in both of the recent forms, is not present in this species.

Frontals.

The facial portion presents many points of difference when compared with *Bos taurus*, but in most respects it is very similar to the

corresponding portion of *Bison americanus.* This portion is more convex and the frontal eminences are more strongly marked than in *Bos.* The orbital portions are much more strongly projected laterally, and more roughened for muscular attachment than in either of the recent forms mentioned; the posterior portions are much broader than in *Bos.* The ridges, connecting the orbits with the bases of the horn-cores and separating the facial from the temporal portion, are not present, the two parts gradually rounding into each other. This ridge is strongly marked in *Bos,* while in *Bison americanus* it is only slightly developed or absent altogether. The horn-cores are proportionally longer and more robust than in the last mentioned species, and are directed less strongly upward and backward. When compared with *Bos* a marked difference in the position of the horn-cores is at once noticed. In this genus the horn-cores are situated far back and occupy the posterior angles of the frontals, while in the bison they are situated just over the root of the zygoma and are separated from the posterior portion of the skull by the anterior wings of the parietals. The anterior surface of the frontals is slightly more convex than in *Bison americanus;* in the ox this portion is slightly concave. The fronto-nasal suture is situated farther forward, and the lateral portions forming the nasal notch are not so sloping as in the ox. The venous foramina, situated above and slightly posterior to the orbits and leading into the frontal sinuses, are present in all of the three forms, but are less numerous in the ox than in the two species of bison under consideration. The supra-orbital notch is not present in *Bison antiquus.*

Nasals.

The nasals are more anteriorly projected than in *Bison americanus,* and are proportionally broader and less arched than in *Bos taurus.* There seems to be no articulation with the maxilla, but on account of the damaged condition of the specimen in this region, this point cannot be accurately determined; in the ox this articulation is very long.

Parietals.

The parietals differ in but few points from the corresponding portion of *Bison americanus.* The parietal eminences are broader and more swollen than in this species, and the swelling invades the frontals somewhat anteriorly. The notch found at the superior portion of the temporal fossa and formed by the anterior wing and the inferior periotic portion of the parietals, is more acute than in *Bison americanus.* In the ox the anterior wings are more vertically placed than in the two species of bison mentioned. In the ox

the superior portion does not invade the forehead (as in the bison), but is almost horizontally situated and forms with the frontal a well rounded crest with which it is anchylosed.

Lachrymal.

The lachrymal differs in but two principal points from that of the recent bison. The orbital portion is more projected laterally and roughened on the rim, and there is a large protuberance on the superior border which slightly invades the frontal.

Premaxilla.

The premaxillæ are much more narrow throughout their course than in *Bison americanus*, and in this lies one of the strong specific characters of this form. The anterior portion at the symphysis is slightly broader from before backward than in *Bison americanus*. The extremities are well rounded and united at the symphysis, a character which does not occur in any of the recent bison skulls which I have examined. The vomer is not preserved.

Maxilla.

The maxillæ are very similar to the corresponding part of the recent bison. The superior portion is slightly more vertically situated than in the form just mentioned. The facial ridge, separating the anterior part from the zygomatic fossa, is more indistinct and the two portions more blended than in the recent bison, but the anterior portion is more prominent and the posterior portion directed more upward than in this species. The infra-orbital foramen is also slightly more anterior in position, approaching the position of this foramen in the ox. The diameter across the facial ridges is less than in the recent bison, making the face proportionally narrower.

Mandible.

The principal point distinguishing the mandible of this species from that of the recent bison is the long and gently sloping horizontal ramus. This portion is also less closely applied to the last molar than in the two recent forms with which it is compared. The condyles are not bifurcate as in the ox, and the coronoids are more curved backward over the root of the zygoma than in this form. The lower portion of the body is not so rounded, and the ridge along the superior border of the diastema is not so sharply defined as in the ox and recent bison.

Dentition.

The teeth of *Bison antiquus* differ in so few points from those of *Bison americanus* that a detailed description of the dentition is unnecessary.

MEASUREMENTS OF SKULL.

	Bison antiquus.	Bison americanus.
Median plane of occiput to extremity of premaxillaries	633	54
Median plane of occiput to tip of nasals	534	412
Anterior rim of orbit to tip of nasals	248	214
Greatest diameter of orbit	74	72
Anterior rim of orbit to tip of horn-core	475	320
Breadth across occipital condyles	147	122
Height of foramen magnum	40	37
Breadth of foramen magnum	48	51
Distance between tips of paroccipital processes	114	110
External auditory meatus to posterior rim of orbit	200	138
Inter-condylloid notch to base of last molar	265	190
Diameter across last molars	122	119
Diameter across first premolars	90	108
Length of superior dental series	155	154
First premolar to tip of premaxillaries	176	148.5
Diameter across premaxillaries four centimeters from tip	72	89
Transverse diameter of external nares	97	95
Mandible, condyle to first premolar	325	288
Mandible, condyle to base of last molar	184	145
Mandible, diameter across condyles	173	155
Mandible, length of inferior dental series	157.5	159
Mandible, length of diastema	127.5*	117
Mandible, depth of symphysis	75*	69
Mandible, depth of ramus at base of third premolar	57.5	46

SKELETON.

The differences in the remaining parts of the skeleton of the two species of Bison are not sufficient to warrant description, but to show the difference in size of the two species measurements of some of the principal parts are given below.

	Bison antiquus.	Bison americanus.
Humerus, length	407	272
Humerus, longitudinal diameter of head	106	86
Humerus, transverse diameter of head	88.5	82.5
Humerus, diameter across condyles, anterior	107	85
Ulna-radius, length from posterior tip of olecranon	490	412
Ulna-radius, length from sigmoid notch	353	316
Ulna-radius, length of sigmoid notch	58	...
Ulna-radius, greatest breadth of olecranon	99	75
Ulna-radius, transverse diameter of proximal end	102	...
Metacarpal, length	221	210
Metacarpal, diameter across proximal end	85	70
Metacarpal, diameter across distal end	88*	76

*Estimated.

	Bison antiquus.	Bison americanus.
Second digit, length of proximal phalanx	66.5	61
Second digit, length of second phalanx	41	38
Second digit, length of ungual	73.5	74
Third digit, length of proximal phalanx	69	62.5
Third digit, length of second phalanx	48	38
Third digit, length of ungual	80	61

HIND LIMB.

	Bison antiquus.	Bison americanus.
Pelvis, antero-inferior spine of ilium to posterior part of ischium	595*	505
Pelvis, greatest transverse diameter of ilium	282	244
Pelvis, center of acetabulum to antero-superior spine of ilium	272*	255
Pelvis, longitudinal diameter of acetabulum	89	78
Femur, length	502	423
Femur, diameter across *trochanter major*	175	153
Femur, greatest diameter of head	67	...
Femur, transverse diameter across condyles	133	116
Tibia, length	461	382
Tibia, transverse diameter of proximal end	141	113
Tibia, transverse diameter of distal end	87	69
Calcaneum, length	175	154
Calcaneum, diameter across sustentaculum	54	44
Astragalus, external length	89	77
Astragalus, internal length	80	72
Astragalus, diameter across proximal condyles	63	50.5
Astragalus, diameter across distal condyles	59	53
Naviculo-cuboid, longitudinal diameter at beak	55	47
Naviculo-cuboid, transverse diameter	77	65.5
Metatarsal, length	270	240
Metatarsal, diameter across proximal end	65	57
Metatarsal, diameter across distal end	78	66
Second digit, length of proximal phalanx	72.5	61
Second digit, length of second phalanx	45	39
Second digit, length of ungual	49	62.5
Second digit, transverse diameter of ungual, posterior	33	26
Third digit, length of proximal phalanx	70	63.5
Third digit, length of second phalanx	48	40
Third digit, length of ungual	65	62
Third digit, transverse diameter of ungual, posterior	30	

*Estimated.

New Species of the Syrphid Genera *Mixogaster* Macq. and *Ceria* Fabr., with Notes.

BY PAUL HUGO ISIDOR KAHL.

Mixogaster breviventris, n. sp.

Black and blackish brown, variegated with yellow bands, black and yellow pubescent; antennæ much elongated, the third joint narrowed in its middle, two and a half times as long as the first one; abdomen narrowed at base, short-pedunculate; wings anteriorly brown, posteriorly greyish hyaline; the fourth vein sends a short vein into the first posterior cell. Length 10 mm., length of wing 8 mm.

Female. Shining, especially conspicuous on pleuræ, sternum and coxæ. Face sparsely covered with yellow pubescence, not projecting more at oral margin than at the antennæ, gently convex, at the insertion of the antennæ not protuberant; yellow with a large, blackish brown, longitudinal median spot, which is gradually dilated from base of antennæ to the lower third of the face, thence contracted to a somewhat acute angle, not quite reaching the oral margin, the spot is black along its middle; across the cheek from the eye to the oral margin a blackish band, behind it a yellow patch, thinly covered with whitish yellow pollen and connected with the yellow of the posterior oral margin; the sides of the lower half of the face with an extremely short, light-yellow pubescence. Front immediately above the antennæ with a broad, almost black, transverse band, reaching the eyes and two-thirds of the distance between base of antennæ and anterior ocellus; above this band there is a yellow, scarcely narrower one, reaching the eyes and encroaching upon the vertex as far as the posterior ocelli; below the yellow band the front is very slightly depressed; on the sides of the black crossband a broad impression, which is continued on the face a short distance as a well marked arcuate line, reaching the eye; the surface of the sides of front uneven, somewhat wrinkled; immediately above the antennæ the surface is smooth, more shining, of brown color, not black like the rest of the crossband.

Vertex behind the yellow frontal crossband black, including the ocellar tubercle, which consists merely of a slightly elevated ring with the space between the ocelli somewhat concave, by no means convex; behind the ocelli a slightly elevated tubercle; front sparsely provided with short, erect fuscous pile on the black band, somewhat lighter on the yellow one; on the vertex the pilosity is fuscous, yellowish at the occiput, more abundant and longer than that of the front. Occiput black, sparsely yellowish pilose above, at the middle with short, at the lower part with longer, sparse whitish yellow pile; superiorly very thinly yellowish pollinose, at the middle of each side a large, distinct, white pollinose patch. Proboscis yellow. Antennæ with the first joint yellowish brown beneath, a little darker above, its length about the same as the distance between its extreme base and the anterior ocellus, its vertical width at apex fully one and a half times greater than that of base, above and beneath with blackish pubescence; the second joint very short, brown, at base darker, scarcely broader than the apex of the first, but at least five times shorter than that joint; third joint thickened, much elongated, fully two and a half times as long as the first one, narrowed in its middle, dark brown; the arista, situated near the base of the third joint, yellowish brown, its extreme base black, not reaching as far as the apex of that joint. Eyes bare; the inner orbits almost parallel and rather broadly separated. Thorax black, the broad lateral border of mesonotum to the scutellum, including humeri, mesopleuræ, upper part of sternopleuræ, upper part of hypopleuræ and most of metapleuræ, pale yellow; the yellow of the pleuræ forms a broad, semicircular band, interrupted only at the posterior side of sternopleuræ by a narrow black stripe connecting the black of pteropleuræ with that of the sternum. Scutellum short, considerably convex, translucent, pale yellow, the extreme base and a dot on lower lateral angle brownish; the furrow between mesonotum and scutellum deep. Abdomen short, a little wider than thorax, blackish brown; first segment rectangular, three times as short as its width, the latter about the same as the distance between the eyes on vertex (not wider), above yellow with a narrow brown, basal band, not quite reaching lateral margin; second segment short, as long as the third, its lateral outline seen from above slightly concave before the middle; first and base of second segments form together a very short peduncle; third and fourth segments of equal width, the fourth hardly longer; fifth as long as the third, its distal end only half as wide as its base; the whole posterior margin of second, third, fourth and fifth dorsal

segments broadly bordered with yellow, that of the second of equal width throughout, that of the third, and a little more so of the fourth, slightly widening at sides, that of the fifth considerably dilated laterally as far as the middle of the segment; ventral segments blackish brown, the first one yellow with a brown patch in its middle, the four following segments with posterior margins narrowly yellow, obsolete on the fifth, base of second also with a narrow yellow, transverse band not reaching the lateral margin; ovipositor dark brown, its two oval apendices reddish brown. To the naked eye the whole insect appears almost bare, and its ground color is in no way concealed by the minute pubescence. Mesonotum rather densely, scutellum very sparsely, the whole blackish portion of second and third dorsal, fourth dorsal at base and sides, fifth dorsal at the extreme base only and the blackish portions of ventral segments, provided with minute blackish brown pubescence; the posterior yellow margins of dorsal and ventral segments with yellow pubescence, extending on the fourth dorsal to the middle of the black portion, on the fifth dorsal it extends almost over the whole segment; on the sides of the first segment and on the ovipositor the pubescence is longer and yellowish. Legs rufous, coxæ black, middle and hind trochanters, apical two-thirds of hind femora, dark brown, basal two-thirds of all the tibiæ pale yellow; the pubescence yellow; hind femora not unusually thickened and the hind metatarsi moderately dilated. Halteres brown with yellow knob. Wings brownish anteriorly, greyish hyaline posteriorly; the brownish color is limited behind by the first, by the spurious as far as the anterior crossvein and by the third veins; apex of the sub-marginal cell is, however, greyish; besides a small spot across the greyish hyaline portion at the outer third of the first basal cell, on veins at base of first and last posterior and discal cells, on vein closing the discal cell, and faintly along fifth vein in the second basal cell, brownish; veins dark brown, somewhat reddish brown at base of wing; posterior angle of first posterior cell less than a right one, the vein closing the same cell almost straight and rectangular with the third vein, sending no stump of a vein inwards, but there is merely an indication of a fuscous dot a little above the middle; posterior crossvein bent inwards, making each outer angle of discal cell much less than a right one, and immediately before the same crossvein the fourth vein sends a short stump of a vein into the first posterior cell; from the posterior angles of the first posterior and discal cells a similar stump of a vein outwards; anterior crossvein situated not more than twice its length from base of

discal cell; the vein closing the anal cell almost straight; the little crossvein, connecting the auxiliary vein before its apex with the first longitudinal vein, present.

A single female specimen from Lawrence, Kansas, captured by the writer July 4, 1894. It was resting on leaf of *Convolvulus sepium L.*

Easily distinguished from the previously described species by the short and at distal end broader second abdominal segment, the much elongate, in its middle narrowed, third antennal joint (like that of *Microdon variegatus* Walker, Ins. Saund. Dipt., p. 220, pl. vi, fig. 6; and *Microdnn pachystylum* Williston, Synops. N. Am. Syrph., p. 8), and the venation of the wings. Notwithstanding the shortness of the second abdominal segment, the pedunculate base of abdomen, though short, and the general appearance will place this species in the genus *Mixogaster.* I have before me males and females of *Mixog. conopsoides* Macq. from Brazil (Dr. Williston's collection), in which the second segment of the female abdomen is broader than that of the male, only a little longer than the third and its distal end as broad as base or distal end of that segment. That Macquart (Diptères Exotiques, II, 2, p. 14, tab. 3, fig. 1), when drawing up the generic characters, had before him a male, and not a female as is stated, is unmistakably shown from his description of the fifth abdominal segment: "cinquième court et arrondi à l'extrémité."

PREVIOUSLY DESCRIBED SPECIES.

M. conopsoides Macquart, Diptères Exotiques, II, 2, p. 14, tab. 3, fig. 1 (Extraits des Mémoires...de Lille, 1841);—Rio de Janeiro. Type of the genus. About the sex see remarks above.—Williston, Diptera Brasiliana, Trans. Amer. Entom. Soc., XV, p. 257.

M. mexicanus Macquart, Dipt. Exot., 1er Suppl., p. 123, tab. 10, fig. 15 (Extr. des Mém...de Lille, 1844)—Mexico, female.—Williston, Biol. Centr. Amer., Dipt., Vol. III, Dec., 1891;—Omilteme in Guerrero 8,000 feet, Chilpancingo 4,600 feet (H. H. Smith). Two male specimens (Dr. Williston's collection), bearing the labels Omilteme, Guerrero, 8,000 ft., July; H. H. Smith, differ so greatly from Macquart's description and figure, that they would be considered a different species, were it safe to rely upon Macquart. Antennæ not longer than front and vertex together (Macq. fig. with much elongated); face with a large, oblong, blackish brown spot from base of antennæ to oral margin; front and vertex black,

upper half of the former yellow (forming a transverse band), the latter in one specimen with an inconspicuous post-ocellar dot yellow (Macquart's female has: "Face jaune, sans bande noire. Front fauve; une tache noire à l'insertion des antennes et une petite protubérance noire au milieu"); scutellum yellow with brown base and a black spot on each lower angle (Macq., "écusson fauve"); coxæ, trochanters, femora (except the rufous knees) and the tibiæ (except the pale almost white basal half of the middle and hind and the basal fourth of the front ones) blackish brown; tarsi dark brown, pulvilli rufous (Macquart's diagnose, "Pedibus rufis").

M. aphritinus Thomson, Kongliga Svenska fregatten Eugenies Resa omkring Jorden, Vetenskapl. Iakttagelser, Diptera, p. 491; 1869.—Sidney (Australia), male.

M. bellula Williston, Biologia Centrali-Americana, Dipt., Vol. III, p. 1, tab. 1, fig. 1, 1a, 1b; 1891.—Mexico, male.

M. dimidiata Giglio-Tos, Diagnosi di nuove specie di Ditteri, VI. Sirfidi del Messico, in Boll. Mus. Zool. Anat. comp. R. Univ. di Torino, Vol. VII, no 123, 1892;—Id., Ditteri del Messico, Parte I, p. 33, tav. I, fig. 9, 9a (Estr. dalle Memorie della Reale Accademia delle Scienze di Torino, Serie II, Tom. XLIII. 1892.)—Tuxpango, female. This species is distinguished by the extraordinary, arcuate impression of the face.

Ceria Willistoni, n. sp.

Syn. *Ceria signifera* Williston (non Loew), Synops. N. Am. Syrph., p. 262.

Black with yellow markings; face with a large, sagittate, black spot; antenniferous process of front almost obsolete; second joint of antennæ about half as long as the third; last section of third longitudinal vein appendiculate and slightly angulate; second abdominal segment much contracted at base; fifth segment black, not at all pollinose. Length about 13.5 mm., length of wing 9.5 mm.

Female. Shining, except the upper three-fourths of front, the black of mesonotum and the sternum, which are opaque; the black of abdomen a little shining only. The perpendicular face, which has a very slight impression at the middle and below a hardly noticeable tubercle, yellow, in the middle with a large black sagittate spot, the broadly rounded apex of which rests on the oral margin and its base narrowly connected with the broad black field below the antennæ; this black field extends transversely to the orbit of the eye, separating the yellow of the face from a small yellow somewhat triangular spot situated at the orbit of the eye

and opposite the base of antennæ; from the antenniferous process to the middle of the sagittate spot a yellowish line, very narrow above, widening below. Cheeks broadly black with an abbreviated yellow stripe from the inferior orbit of the eye. Front black, broadly connected with the black below the antennæ; a little below the middle two small, narrowly separated, reddish brown, transverse spots; the opaque portion of the front thinly white pollinose, seen in certain lights only and most conspicuously at the orbit of the eye. Vertex reddish brown, behind the ocelli with two yellow dots placed in a transverse line; the vertex and the sides of front below thinly provided with yellowish pile. Occiput black, thinly white pilose and white pollinose, the latter conspicuous along the orbit of the eye only. Antenniferous process very little projecting above, wholly obsolete below, brownish yellow. Antennæ black, the basal two-thirds of the first joint reddish brown; the first joint slender, scarcely longer than the third and its style together or about as long as the front tibiæ; the second joint scarcely more than half as long as the third. Thorax black with inconspicuous, very minute, brownish pubescence on mesonotum; humeral callus, an oblique, oval spot on presutural depression, an elongate spot on mesopleuræ along the mesopleural suture and below it an oval oblique spot on sternopleuræ along the posterior end of the sternopleural suture, yellowish; on each side of mesonotum a reddish brown, from above seen outwardly arched stripe, beginning a little in front of the scutellar ridge and extending to the transverse suture; along the middle of mesonotum in front two parallel, narrow, yellowish pollinose stripes, not quite reaching the anterior border, but each one terminating in a transverse, yellowish pollinose spot on the transverse suture, behind which the stripes are faintly visible; the black ground color is concealed by the pollen of those stripes; sternum very thinly whitish pollinose. Scutellum reddish brown, towards the sides yellowish brown, the extreme base and lateral angles black, the posterior margin narrowly brown. Abdomen above black, much contracted at the base of the second segment, provided with short, appressed yellowish pubescence, that of the sides of the first segment longer, erect and whitish; the ground color is not at all concealed by the pubescence; second segment as long as the third, with a small yellow basal spot on each side; each one of the second and third segments on the posterior margin with a yellow band of equal width throughout and reaching the lateral margin, the band of the second segment a little broader; on the posterior margin of the fourth segment a narrower

yellow band with its anterior outline convex and not reaching the lateral margin; on each side of the third and fourth segments a somewhat V or U-shaped, yellowish pollinose mark, concealing the black ground color, both its branches diverging and not reaching the preceding segment, the inner branch of one mark converging with that of the other; fifth segment wholly black, not at all pollinose, the sparse pubescence, mixed yellowish and blackish, in no way concealing the ground color; the ventral segments black, posteriorly margined with pale yellow on the second, third and fourth segments, very narrowly on the fourth. broadest on the second, thinly provided with whitish pubescence. Legs dark reddish brown; coxæ black, brownish at tip; all trochanters, the extreme base of the front and middle femora, the base of the hind ones broadly, the knees, the base of all the tibiæ, broadly on the middle and hind ones, and the two basal joints of the middle tarsi, yellowish; the color at base of tibiæ pale; the third and fourth joints of the front and middle tarsi, and the four distal joints of the hind ones, blackish; basal half of the front femora black; hind side of middle femora fringed with whitish hairs; the distal half of the femora beneath with two rows of minute black spines, most conspicuous on the hind, least on the front ones; hind femora thickened, but not more so in the middle. Halteres and tegulæ yellowish. Wings with the anterior half brown, the posterior one hyaline; the brown is limited posteriorly by the fourth vein at base, and by the spurious vein to very little beyond the anterior crossvein, wherefrom the brown extends with the outline concave to the third vein, narrowly bordering it posteriorly a short distance before the stump of a vein, which it follows exteriorly, thereafter rather broadly bordering the third vein posteriorly with its outline diverging from that vein; the extreme margin of the wing immediately beyond the apex of the third vein is, however, greyish hyaline, not brown; at base of the wing the color is yellowish; the cells in the brown field are somewhat lighter along their middle. The veins are dark brown, at the base of the wing and the portion of the fifth vein between second basal and anal cells yellowish brown; this portion of the fifth vein is anteriorly and posteriorly bordered with yellowish brown, which encroaches upon the extreme base of the third posterior cell; last section of the third vein forms before its middle a very slight angle, wherefrom a short vein projects into the first posterior cell.

Three female specimens captured by the writer at Lawrence, Kansas. Dedicated to my learned friend, the eminent dipterologist, Dr. S. W. Williston, of Kansas State University.

The specimen, from which the description is drawn, was captured on flowers of *Rubus* May 18, 1895. Of the other two, one was captured May 23, 1896, the other May 16, 1897; the former has the brown color of wings more even throughout; on each side of the second abdominal segment at base between the lateral yellow spot and the black dorsal middle the color is dark reddish brown; the latter with the impression of the face more conspicuous; both are more robust, first joint of antennæ blackened at the extreme apex only, scutellum with disk yellow, not reddish or brownish (the yellow ground color may change after death to yellowish or reddish brown); all three specimens belong, however, to the same species.

To *Ceria Willistoni*, n. sp. I refer *Ceria signifera* described by Williston in his Synopsis of N. Amer. Syrphidæ, 1886, p. 262. Williston writes: "One male specimen from Professor Riley's collection (Florida), and three females in the Loew type collection from Texas (Boll), bearing the label 'signifera?' in Loew's writing. I find discrepancies in the original description which make me doubt that this determination is the correct one." The specimens from Texas, included under *C. signifera* Loew in the Catal. N. Amer. Diptera, 1878, p. 139, by Osten Sacken, are also referred to *C. Willistoni* n. sp., as being the same ones that Professor Williston examined in the Loew type collection of the Mus. Comp. Zool., Cambridge, Mass.

Giglio-Tos (Ditteri del Messico, I, p. 32; 1892) writes about the single female (*C. signifera* Loew) before him: "L'esemplare femmina, che ho esaminato, corrisponde bene alle descrizioni minute del Loew e del Williston." Giglio-Tos was not aware, however, of the differences in the respective descriptions of those dipterologists regarding the antennal joints; whether or not his female from Cordova (Mexico) is the *C. signifera* Loew has still to be ascertained.

Professor Johnson in his list "Diptera of Florida" (in the Proc. Acad. Nat. Sc., Philadelphia, 1895,) records "*Ceria signifera* Loew, Inverness, February 12, 14 (Robertson)," but as his record is not accompanied by other notes, it may be doubtful whether his specimens belong to Loew's *signifera*. The occurrence of *C. signifera* Loew in the U. S. has yet to be confirmed.

Ceria signifera Loew (Neue Beiträge I, p. 18, 19: 1853,) and *Ceria Willistoni* n. sp. differ essentially as follows:

Ceria signifera Loew. Female.

Antennæ—"das 2te Fühlerglied fast noch einmal so lang als das 3te," . . .

Scutellum—"Schildchen ganz gelb; sein Rand an den Seiten rostbräunlich."

Abdomen—"5ter Ring gelbbraun, an der Wurzel, auf der Mittellinie und an der Spitze schwarz, überall mit gelber Bestäubung bedeckt, welche die Grundfarbe schwer erkennen lässt."

The brown of the wing—"am dunkelsten in der Nähe der 3ten Längsader, über welche sie nirgends erheblich hinausreicht."

Ceria Willistoni. n. sp. Female.

Second antennal joint scarcely more than half as long as the third.

Scutellum reddish brown or yellow, the base and lateral angles black, the posterior margin narrowly brown.

Fifth abdominal segment wholly black, nowhere pollinose, the sparse pubescence in no way concealing the ground color.

The brown of the wing reaches the spurious vein in the first basal cell and borders the last section of third vein posteriorly rather broadly, except a short distance before the short vein that projects into first posterior cell.

That there is a typographical error in Loew's statements, "Long. corp. 3½'" (p. 18, diagn.) for Long. corp. 5½ as suspected by Giglio-Tos and "die 3te Längsader gelblich," etc., (p. 19, below) for die 5te Längsader gelblich, etc., I judge from the fact that Loew, when pointing out the most conspicuous differences between *C. arietis* male and *C. signifera* female (p. 18), mentions neither the striking differences in the proportion between length of body and wing of the two so closely allied species, nor any difference in the color of and about the 5th (that is, "vorletzte") or 3d vein; he does not mention the fifth ("vorletzte") vein in the description of *signifera*, but does in that of *arietis*. If those differences actually existed, he would certainly have paid some attention to them.

It may not be without importance to here point out that Loew in his descriptions of *Ceria arietis* (p. 18) and *Ceria signifera* (p. 19) writes regarding the antennæ, the former "zweites Glied fast noch einmal so lang als das 3te," the latter "das 2te Fühlerglied fast noch einmal so lang als das 3te;" and on p. 18 below he says, that the two would be considered the different sexes of the same species, but there are differences that cannot be considered sexual,

and the most conspicuous of those are, "dass bei *Ceria arietis* die 1ste und 2te Längsader einander viel näher liegen und viel paralleler laufen, als bei *Ceria signifera.*"

Finally I will state, that I have used the genus *Ceria* in the sense of Loew in the "Neue Beiträge I." Bigot's (Ann. Soc. Ent. de France, 1883) separation of the genus into two *distinct* genera I consider hastily done. Though *Ceria* Fabr. (1794) is preoccupied by *Ceria* Scop. (1763), which is *Scatopse* Geoffr. (1764), I have hesitated to substitute for the familiar Fabrician genus that of the "unglücklich gebildeten" (Loew, Neue Beiträge, I, p. 5) *Sphiximorpha* Rondani. I believe, however, that Williston's view (Manual N. Am. Dipt., 1896) will be generally accepted. See Osten Sacken "Priorität oder Continuität" (Wien Ent. Zeit. I (1882). Heft. 8.) and Bergroth "Zur Nomenclatur der Dipteren" (Ent. Nachr. Jahrg. XIII (1887), No. 10).





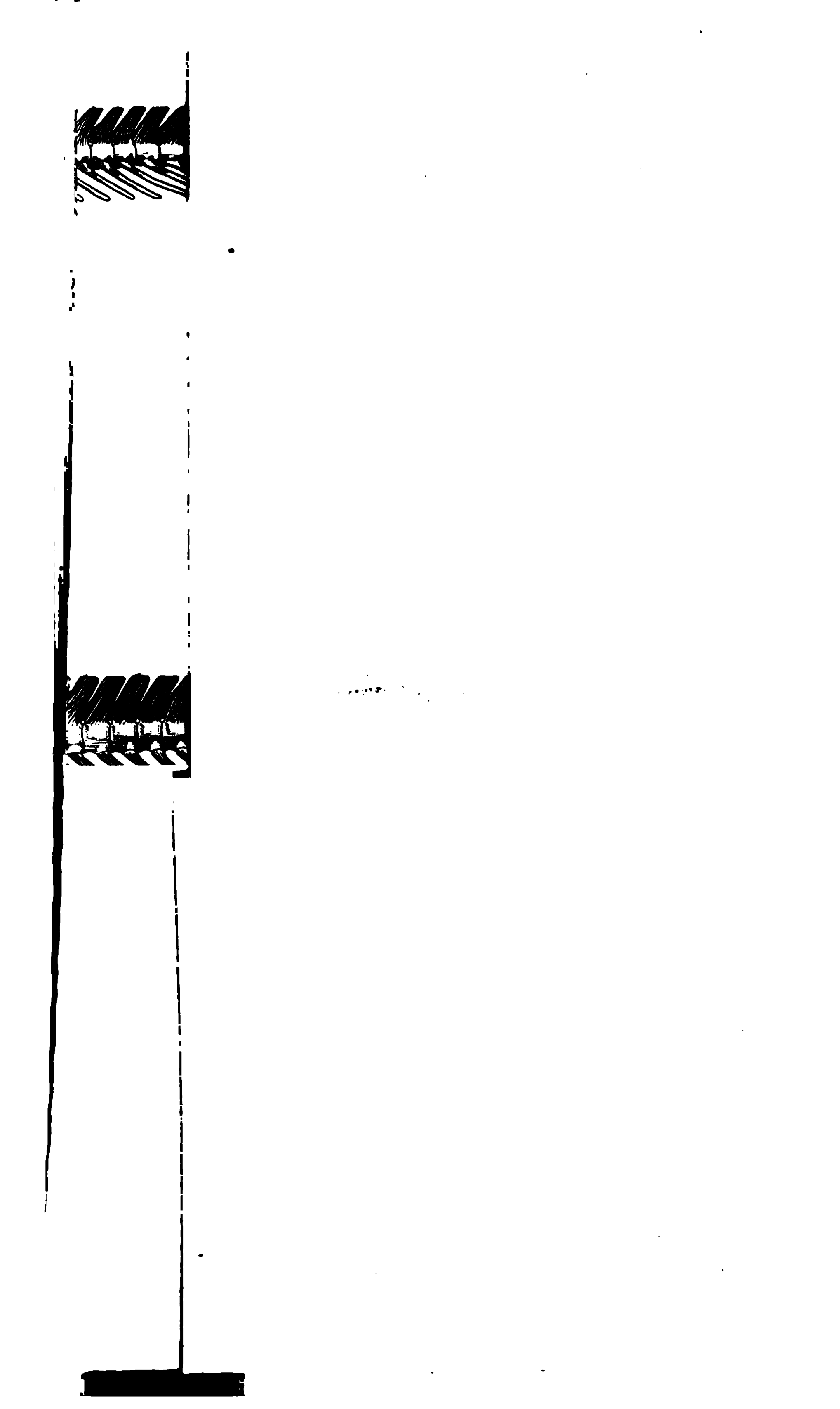


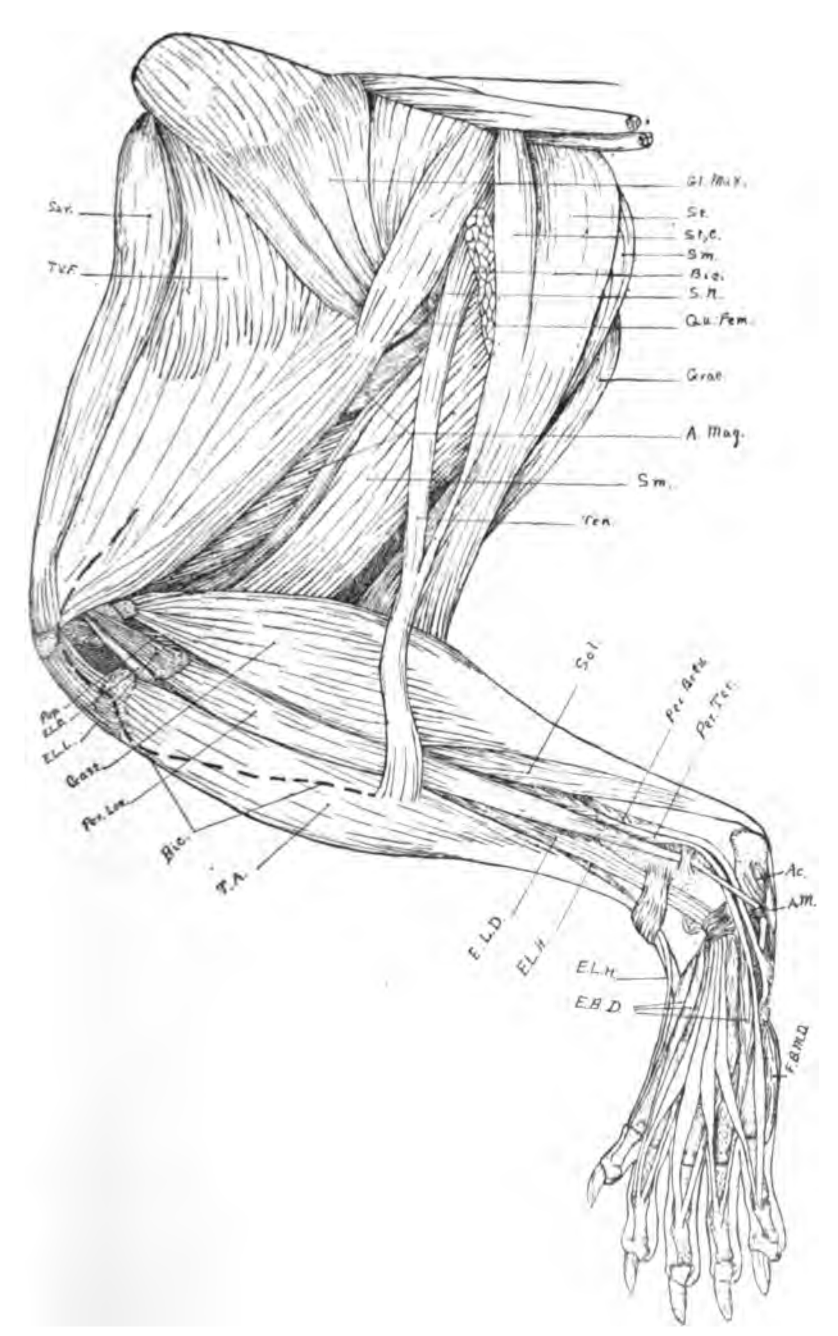
PLATE XIV.

Plate XIV. Hind limb of the Raccoon, lateral aspect, Biceps removed, and dorsum of pes everted.

Thigh. Sar., Sartorius; T. V. F., Tensor vaginæ femoris; Gl. Max., Gluteus maximus; St. Semitendinosus; St. c., Caudal division of same; Sm. Semimembranosus; Bic., cut origin of Biceps femoris; S. n., Sciatic nerve; Ten., Tenuissimus.

Crus. Pop., Popliteus; E. L. D., Extensor longus digitorum; E. L. L., External lateral ligament; Gast., Gastrocnemius; Per. lon., Peroneus longus; Bic., Biceps, line of insertion; T. A., Tibialis anticus; E. L. D., Extensor longus digitorum; E. L. H., Extensor longus hallucis; Sol., Soleus; Per. brev., Peroneus brevis; Per. Ter., Peroneus tertius.

Pes. E. L. H., Extensor longus hallucis; E. B. D., Extensor brevis digitorum; Ac., Accessorius; A. M., Abductor minimi digiti; F. B. M. D., Flexor brevis minimi digiti.



HIND LEG OF RACCOON, LATERAL ASPECT.

R. C. Gowell, del.



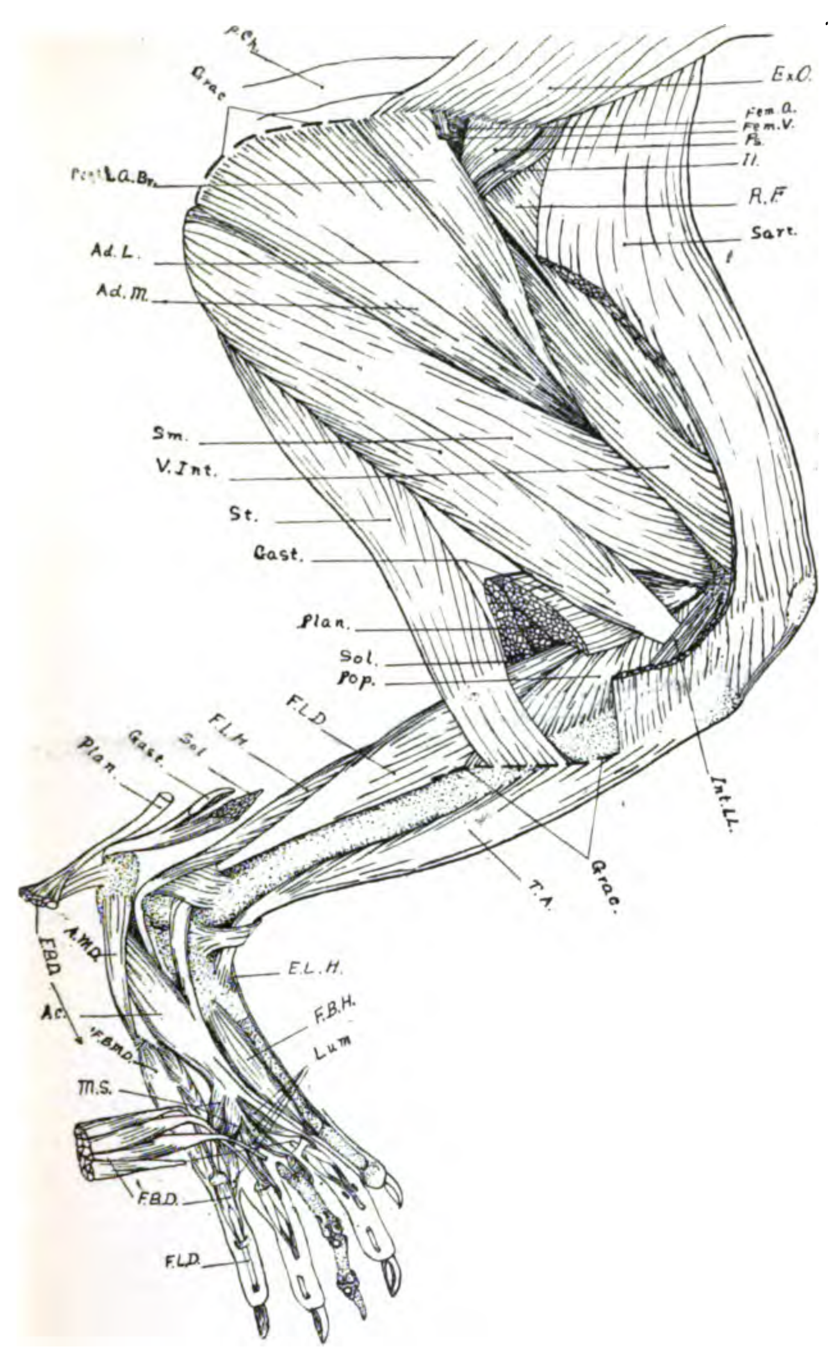
PLATE XV.

Plate XV. Hind limb of Raccoon, mesal aspect, Gracilis and parts of several muscles removed.

Thigh. Grac., Origin of Gracilis; Pect. and A. Br., Pectineus and Adductor brevis; Ad. L., Adductor longus; Ad. M , Adductor magnus; Sm., Semimembranosus; V. Int., Vastus internus; St., Semitendinosus; Sart., Sartorius; R. F., Rectus femoris; Il., Iliacus; Ps., Psoas; Fem. V., Femoral vein; Fem. A., Femoral artery; Ex. O., External oblique; Sp. Ch., Spermatic Chord.

Crus. Gast., Gastrocnemius; Plan., Plantaris; Sol., Soleus; Pop., Popliteus; F. L. D., Flexor longus digitorum; F. L. H., Flexor longus hallucis; T. A., Tibialis anticus; Grac., insertion of Gracilis; Int. L. L., Internal lateral ligament.

Pes. F. B. D., Flexor brevis digitorum, cut and reflected; A. M. D., Abductor minimi digiti; Ac., Accessorius; F. B. M. D., Flexor brevis minimi digiti; M. S., Muscular slips connecting long and short flexor tendons; Lum., Lumbricales, F. B. H., Flexor brevis hallucis; E. L. H., Extensor longus hallucis.



HIND LEG OF RACCOON, MESAL ASPECT.

R. C. Gowell, del.

PLATE XVI.

Plate XVI. Figs. 1 to 4, showing areas of muscular attachment on the Femur:

Fig. 1, Posterior surface of the Femur.

Fig. 2, Anterior surface of the Femur.

Fig. 3, Lateral surface of the Femur.

Fig. 4, Mesal surface of the Femur.

Gl. min., Gluteus minimus; Gl. Med., Gluteus medius; Gl. Max., Gluteus maximus; Ps. and I., Psoas magnus and Iliacus; Qu., Quadratus femoris; P. et A. B., Pectineus and Adductor brevis; A. L., Adductor longus; A. Mag., Adductor magnus; Sm. Semimembranosus, femoral portion; G. Int. and G. Ext., Internal and external heads of Gastrocnemius. The external head arises in common with the Plantarius from a sesamoid.

Figs. 5 to 8, showing areas of muscular attachment to Tibia and Fibula:

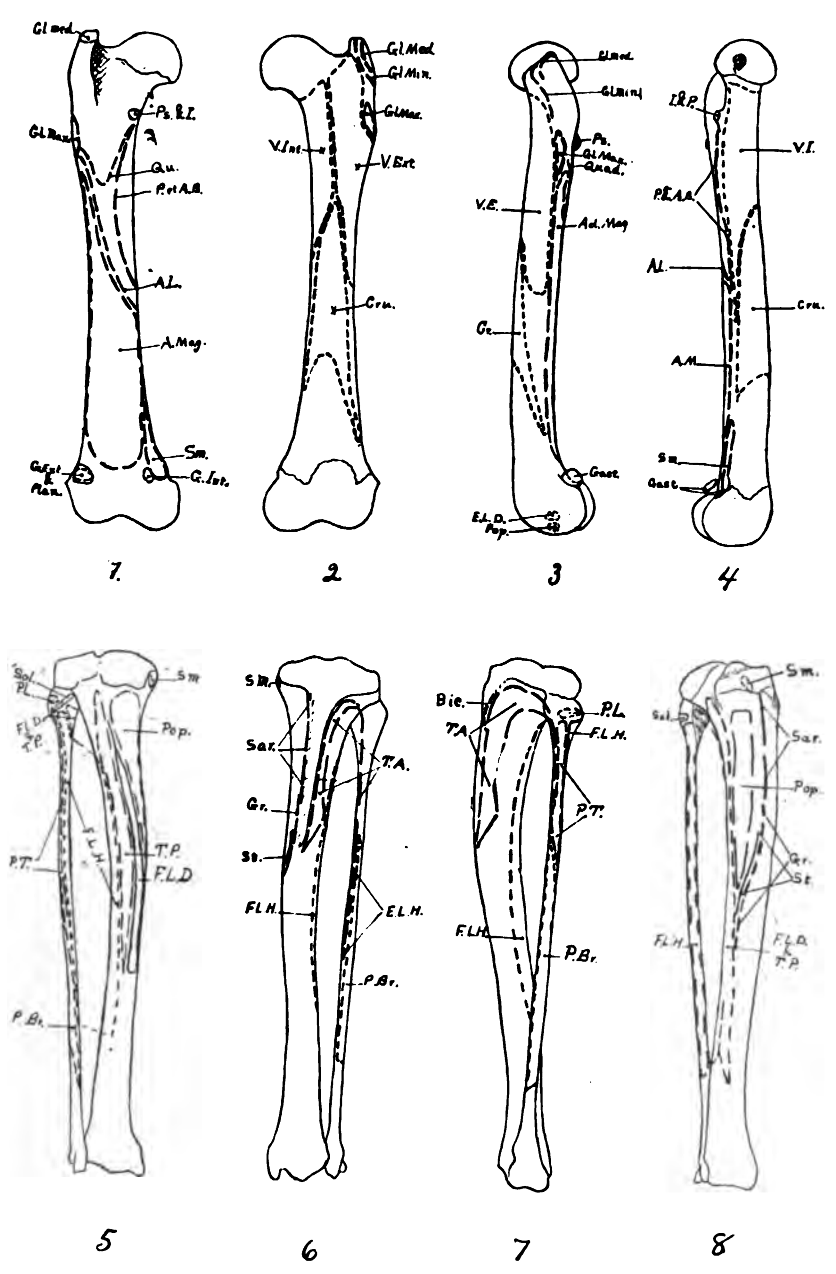
Fig. 5, Posterior surface of Tibia and Fibula.

Fig. 6, Anterior surface of Tibia and Fibula.

Fig. 7, Lateral surface of Tibia and Fibula.

Fig. 8, Mesal surface of Tibia and Fibula.

Sol., Soleus; P. L., Peroneus longus; F. L. D. and T. P., Flexor longus digitorum and Tibialis posticus; P. T. Peroneus tertius; P. Br., Peroneus brevis; F. L. D., Flexor longus digitorum; T. P., Tibialis posticus; F. L. H., Flexor longus hallucis; Pop., Popliteus; Sm., Semimembranosus; Sar., Sartorius; Gr., Gracilis; St., Semitendinosus; E. L. H. Extensor longus hallucis; T. A., Tibialis anticus; Bic., Part of insertion of Biceps.



Hind Leg of Raccoon, Areas of Muscular Attachment.

R. C. Gowell, del.

PLATE XVII.

Plate XVII. Fig. 1, posterior view of skull in high school in Illinois. Fig. 2, side view of skull in Kansas University Museum.



Fig. 1.

Fig. 2.

Vol. VI. OCTOBER, 1897. No. 4.

THE KANSAS UNIVERSITY QUARTERLY.



SERIES A:—SCIENCE AND MATHEMATICS.

CONTENTS

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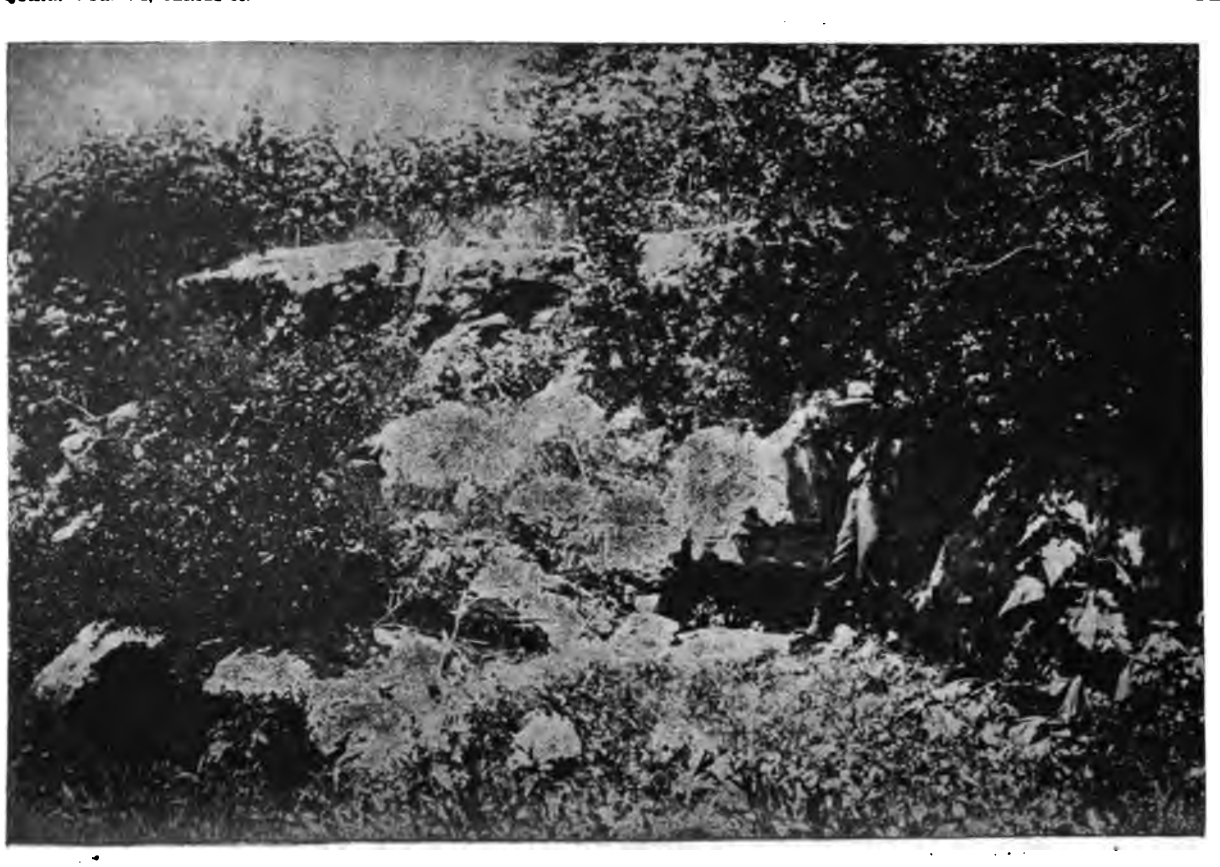
PLATE XVIII.

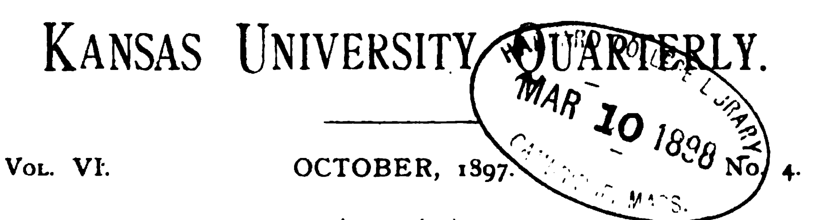
With the article "The Permian and Upper Carboniferous."

Plate XVIII. View of a massive stratum four feet thick of the Strong limestone on the eastern side of the Flint Hills to the west of Reece. Along the edge of the stratum are large numbers of loose, rectangular blocks, which have broken off from its edge on account of the more rapid decomposition of the underlying shales and shaly limestones. These blocks are well shown in the picture.

PLATE XIX.

Plate XIX. View of outcrop of Florence limestone on Spring creek, two and a one-fourth miles south of Rock.





KANSAS UNIVERSITY QUARTERLY.

VOL. VI. OCTOBER, 1897. No. 4.

The Permian and Upper Carboniferous of Southern Kansas.[1]

BY CHARLES S. PROSSER.

SYNOPSIS.

Introduction.

In the summer of 1896 the writer rapidly reviewed the fossiliferous Permian and Upper Carboniferous formations of southern Kansas as exposed in parts of Greenwood, Butler, Elk, Cowley and Sumner counties. Although the time at the writer's disposal did not permit a sufficiently thorough study of the region to deter-

1 Published by permission of the director of the Univ. Geol. Survey of Kansas.

mine all the stratigraphic details, it is considered that the observations are sufficiently valuable to be worthy of record. To the north of this region the Permian and Upper Carboniferous rocks of central Kansas have been somewhat fully described by the writer,[1] as well as those along the southern border of the state, from the western part of Cowley county westward.[2] The Upper Carboniferous formations under consideration—the Wabaunsee and Cottonwood—form the upper part of the Missourian series of Keyes; while the Neosho, Chase and Marion comprise all the Permian formations of Kansas in which fossils have been found in that state. For these three Permian formations and the overlying Wellington shales Prof. Cragin has proposed the name Big Blue series from the Big Blue river, in northern Kansas and southern Nebraska.[3] In southern Kansas, succeeding the Wellington shales, is a mass of red sandstones and shales, with a prominent gypsum deposit in the upper part, which is known as the Red-beds, or Cimarron series. These rocks have been recently quite fully described by Prof. Cragin[4] and the writer;[5] but there is uncertainty as to their age. Prof. Cragin in his work correlated the series with the Texas Permian, and this correlation was accepted provisionally by the writer in the Kansas report. In that report a full review of the various published opinions in regard to the age of the Cimarron series was given, but since it was written three papers have been published referring to this question, which may be noticed in this connection. Dr. Williston says: "That these red-beds are not contemporaneous with the Texas Permian would seem assured, and I feel yet more confident that they are, what they were first considered to be, of Triassic age."[6]

In another publication Dr. Williston virtually expresses the same opinion when he says: "I believe yet more strongly, what I always have believed, that the red-beds of Kansas are Triassic in age."[7] It is quite true that their general lithologic appearance is certainly very similar to that of the Triassic rocks in other parts of the United States.

Prof. Grimsley, who has carefully studied the Kansas gypsum deposits, says that the Red-beds "probably mark the transition from Permian to Cretaceous."[8]

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1 Bull. Geol. Soc. Amer., vol. vi, 1894, p. 29. Jour. Geol., vol. iii, 1895, pp. 682, 764. Univ. Geol. Surv. Kan., vol. ii, 1897, p. 58.
2 Univ. Geol. Surv. Kan., vol. ii, p. 64, etc.
3 Col. Coll. Studies, vol. vi, 1896, pp. 3, 5.
4 Col. Coll. Stules, vol. vi, p. 18.
5 Univ. Geol. Surv. Kan., vol. ii, p. 75.
6 Science, N. S., vol. v, March 5, 1897, p. 395.
7 Kan. Univ. Quar., vol. vi, Jan., 1897, Ser. A., p. 56.
8 Bull. Geol. Soc. Amer., vol. viii, March, 1897, p. 236. Kan. Univ. Quar., vol. vi, Jan., 1897, Ser. A, p. 17, for the same statement.

Finally, Mr. Vaughan, of the U. S. Geological Survey, who is studying the Upper Paleozoic and Cretaceous rocks of Oklahoma and Indian Territories and southern Kansas, under the direction of Prof. Robert T. Hill, speaks of the Red-beds as "Permotrias," and states that "no definite line could be drawn between the Carboniferous and the Permian, or between the Permian and the Trias,"[1] in that region.

Mr. C. N. Gould writes me under recent date that he found, in a soft red sandstone not more than 100 feet above the base of the Red-beds or Cimarron series, eight miles west and three miles south of Blackwell, Oklahoma, or about sixteen miles south of Hunnewell, Sumner county, Kansas, a number of invertebrate shells. Mr. Gould states that the lower line of the Red-beds swings around farther to the east in the territory than it does in Kansas.

In this paper no further attention will be given to the rocks above the Marion formation; and if the reader be interested in the higher formations he is referred to the papers already mentioned for fuller details.

Greenwood and Butler Counties.

While engaged in mapping the Cottonwood Falls sheet the Permian formations were followed into the northern part of Butler county, where they were not well exposed on the high prairie which forms the divide between the Cottonwood river valley on the north and the head waters of the Walnut and Whitewater rivers on the south. Consequently a section was sought that would show the stratigraphic details of these formations, and the line of the Missouri Pacific railroad, from Eureka to El Dorado, crossing the prominent ridge of the Flint Hills along the Greenwood-Butler county line[2] seemed to offer such a section, and this was studied. A paper giving a somewhat general account of the geology of this section was published in 1890 by Prof. L. C. Wooster.[3]

The writer was anxious in the first place to find the Cottonwood limestone, which, in his previous work, had been traced into the eastern part of Chase county, some thirty-five miles north of this section, and then to study the overlying Permian formations. It was estimated that the horizon of the Cottonwood limestone would be found somewhere in the vicinity of Reece, Greenwood county,

1 Paper read before the Geol. Soc. Washington, March 10, 1897, and reported by W. F. Morsell in Science N. S., vol. v, April 2, 1897, p. 559.

2 A clear idea of this ridge in southern Kansas may be obtained from a "Contour map of southeastern Kansas showing the Flint Hills," by Geo. I. Adams, in Univ. Geol. Surv. Kan., vol. i, pl. ix.

3 Amer. Geol., vol. vi, p. 9, under the title of "The Permo-Carboniferous of Greenwood and Butler Counties, Kansas."

consequently a careful examination of the rocks was begun near this town, nine miles south of west of Eureka. This village is situated on the northern side of the Spring creek valley on the Missouri Pacific railroad, 137 feet above Eureka, to the west of which is the fairly steep eastern slope of the Flint Hills, affording natural exposures of the rocks and in addition the railroad cuts furnish several excellent sections, especially toward the crest of the ridge.

SECTION ALONG THE MISSOURI PACIFIC RAILROAD FROM REECE TO THE CREST OF THE FLINT HILLS.

Crest of Flint Hills on Missouri Pacific railroad:

No.		Feet.
15.	Massive light gray limestone and flint or chert.[1] This forms a conspicuous stratum near the eastern crest of the hills, as shown in the picture. Well exposed in the railroad cut at the eastern crest of the hills.	10=390[2]
14.	Bluish and yellowish shaly limestones with abundant fossils. Lower part maroon, bluish and yellowish calcareous shales.	29=380
13.	Massive stratum of light gray limestone, containing a large amount of flint in layers.	11=351
	(Nos. 13, 14, and 15 are Strong flint.)	
12.	Upper part yellowish shales, containing abundant specimens of *Derbya;* top of the *Neosho* formation. Greater part maroon, calcareous shales, well exposed in the lower part of the railroad cut west of the trestle, where they are capped by the lower part of the flint.	65=340
11.	Grayish to yellowish shaly limestones, in railroad cut 2000 feet east of the trestle, containing *Pseudomonotis.* Lower part of this zone covered.	25=275
10.	Rough, jagged limestone, containing iron concretions 2 to 2½ feet thick.	2=250
9.	Covered	38=248
8.	Massive limestone that weathers to a rough, jagged rock, 4 to 5 feet thick.	5=210
7.	Covered	20=205
6.	Shaly limestones and yellowish shales in railroad cut, about one-half the distance from Reece to the trestle. Lower part of zone covered.	35=185

---

1 The name "flint" has been so universally used for the siliclous deposits of the Kansas Permian that it seems better to use it here rather than the more precise term chert.

2 Prof. Wooster gave the dip as 20 feet per mile to the west, along the line of this railroad (*Op. cit.*, p. 10), and if this estimate be correct it will add 100 feet or more to the thickness of the rocks in the above section. In a letter Prof. Wooster states that the average dip at Eureka is about 12 feet per mile to the southwest.

No.		Feet.
5.	Bluish, shaly limestone at top, containing *Aviculopecten*. The greater part of the zone covered.	50=150
4.	Massive limestone, containing flint and abundant specimens of *Fusulina*, 3 inches in thickness.	3=100
3.	Yellowish shales and thin limestones, containing *Spirifer cameratus*.	10±97[1]
2.	Massive limestone, containing abundant specimens of *Fusulina*, about 2 feet thick. Nos. 2 to 4 exposed in the railroad cut 1½ miles west of Reece.	2=87
1.	Mostly covered, but just west of Reece are thin, shaly limestones, which weather to a brownish red color.	85=85

Reece railroad station.

CORRELATION AND PALEONTOLOGY.—Nos. 13, 14, and 15, of the above section, which are well shown in the three railroad cuts between the trestle and the summit, the western one being about one-half mile east of Summit station, are correlated with the Strong flint which forms the lower part of the Chase formation. The similarity of these zones to those of the Strong flint is very marked when this part of the section is compared with a complete one of the Strong flint as exposed in the Cottonwood or Neosho valleys to the north. In the section near Council Grove the lower layer of limestone and flint has a thickness of seven and a half feet, then there are twenty-one and a half feet of light gray limestones and rather coarse yellowish shales, in the upper part of which are abundant fossils; above these is a heavy limestone containing an abundance of coarse flint, ten feet in thickness, which is capped by a massive gray limestone three feet thick.[2] This gives a thickness of forty-two feet for the Strong limestones and flint near Council Grove, while in the Reece section the thickness is fifty feet. In places the upper layer of flinty limestone contains only a small quantity of flint and constitutes a massive ledge of light gray limestone. This stratum frequently forms a prominent outcrop near

---

1 At the time of my visit these shales were hastily measured; but since then Prof. Wooster has sent me a section of the cut in which the thickness for the shaly zone foots up 17 feet. The section is as follows:

No.		Ft.	In.
10.	Buff limestone, four layers; a few fossils, mostly *Fusulina*	3	
9.	Buff shale	5	
8.	Carbonaceous shale	2	
7.	Buff, shaly limestone; fossils	1	6
6.	Blue shale, full of fossils	3	4
5	Buff limestone, one layer	1	9
4.	Buff calcareous shale		9
3.	Buff *Fusulina* limestone	1	8
2.	Dark shale, buff on weathered surface; no fossils	3	
1.	Buff limestone, top layer is blue and full of *Fusulina*	2	

In this section Nos. 1 and 10 correspond to Nos. 2 and 4 of my section, while Nos. 2 to 9 are included in my No. 3.

2 Jour. Geol., vol. iii, p. 773.

the crest of the Flint Hills, as is shown in the picture of the massive ledge four feet thick south of the railroad at the western cut. The upper part of the shaly limestones—No. 14—are of bluish and yellowish color and contain great numbers of fossils, as does the similar zone described on Elm creek west of Council Grove,[1] and in the railroad cut east of Grand Summit, Cowley county. The upper layer of the limestone and flint with the fossiliferous zone of the shaly limestones is nicely shown in the western railroad cut, about a half mile east of Summit station; the base of the lower limestone and flint in the cut immediately west of the trestle, and the middle part of the sub-formation in the intervening cuts.

In the railroad cut, just west of the trestle, the upper part of the Neosho formation is admirably shown, the top of the cut being in the base of the Strong flint. The upper part of the Neosho is composed of a zone of yellowish shales containing specimens of *Derbya*, which are apparently nearer *D. multistriata* (M. and H.) Pros. than *D. crassa* (M. and H.) H. and C., and a few other species similar to the zone of yellowish shales exposed at the top of the Neosho formation on the Crusher Hill west of Strong City.[2]

In the railroad cut 2,000 feet east of the trestle are grayish to yellowish shaly limestones—No. 11—in which specimens of *Pseudomonotis Hawni* (M. and H.) are common. The following species were collected in this cut:

1. *Productus nebrascensis*, Owen........................ (c)
   Part of the specimens have larger and longer spines than is generally the case for this species. Possibly not larger than on fig. 3, b. and c., pl. XXVII, Pt. II, Pal. Missouri.
2. *Pseudomonotis Hawni* (M and H.).................... (c)
3. *Aviculopecten occidentalis* (Shum.) M. and W........... (c)
4. *Spirorbis* sp.................................... (c)
   This zone is probably near the middle of the Neosho formation.

East of this cut the greater part of the surface is covered by soil, and most of the railroad cuts are shallow so that the base of the Neosho formation was not accurately determined. Again, apparently, the Cottonwood limestone which forms such striking massive outcrops to the north, in Chase and Lyon counties, has lost its massive structure and does not form conspicuous outcrops in the western central part of Greenwood county.

1 Ibid., p. 774.
2 Ibid., p 767, No. 16.

The massive limestone of No. 8, which weathers to a rough, jagged rock, is somewhat similar to a stratum twenty-six feet above the base of the Neosho formation in the Cottonwood valley,[1] and it is referred to the Neosho formation. It seems probable that the base of the Neosho formation is either in No. 7 or 6, and the horizon of the Cottonwood limestone is also either in No. 7 or 6 of the Reece section. This would agree fairly well with the Cottonwood river section, where the Neosho formation has a thickness of 130 feet and it is 144 feet from the top of the Cottonwood limestone to the base of the Strong flint.

If the above correlation be correct then the massive limestones forming Nos. 2 and 4 of the Reece section are in the Wabaunsee formation, possibly ninety feet or more below its top. The thickness of the rocks between the top of No. 4 and the supposed horizon of the Cottonwood limestone in this section agrees quite closely with the upper part of the Wabaunsee formation as exposed in the bluff of the Cottonwood river east of Elmdale. The Elmdale section is as follows:

No.		Feet.
6.	Cottonwood limestone, light gray, containing large numbers of *Fusulina*, near top of bluff.	
5.	Mostly covered................................	30=165
4.	A ledge of conspicuous limestone which weathers to a very rough surface. "Dry bone limestone" of Swallow.	5=135
3.	Partly covered	60=130
2.	A buff to light gray limestone containing *Fusulina*, from 3½ to 4 feet thick. At the base greenish shales containing fossils in fair abundance as, *Spirifer cameratus* Mort., *Athyris subtilita* (Hall) Newb., *Chonetes granulifera* Owen, *Productus semireticulatus* (Martin) de Koninck and others.	4=70
1.	Mostly covered to level of the Cottonwood river.....	66-66

Another reason for referring the limestones of Nos. 2 and 4 of the Reece section to the Wabaunsee formation is the occurrence of *Spirifer cameratus* Mort. in the shales between them, which species has not been found above the Cottonwood limestone in the region where it is well shown. From the shales of No. 3 the following species were obtained:

1. *Productus cora* d'Orbigny.............................. (a)
2. *Productus semireticulatus* (Martin) de Kon............. (r)

1 Ibid., p. 765, No. 8.

3. *Productus nebrascensis* Owen .... (rr)
4. *Productus longispinus* Sowb .... (rr)
5. *Spirifer cameratus* Mort .... (c)
6. *Spirifer (Martinia) planoconvexus* Shum .... (r)
7. *Derbya crassa* (M. and H.) H. and C .... (c)
8. *Athyris (Seminula) subtilita* (Hall) Newb .... (rr)
9. *Hustedia mormonii* (Marcou) H. and C .... (rr)
10. *Chonetes granulifera* Owen .... (rr)
11. *Meekella striato-costata* (Cox) White and St. John .... (c)
12. *Fusulina cylindrica* Fisher .... (a)
13. *Septopora biserialis* (Swallow) Waagen .... (rr)

In addition to the above list Prof. Wooster has identified the following species from this cut:

Aviculopecten occidentalis (Shum.) Meek and Worth.
Rhynchonella uta (Marcou) Meek.
Spiriferina Kentuckensis Shum.
Dielasma bovidens (Morton) H. and C.
Bellerophon carbonarius Cox.
Pseudomonotis Hawni (M. and H.) var, *sinuata* M. and W.
Phillipsia sp.
Archæocidaris sp.
Eocidaris sp.

The bluish shaly limestone of No. 5 contains fossils, *Aviculopecten occidentalis* (Shum.) Meek and Worth, *Myalina* sp. and a few other species having been noticed. From this cut Prof. Wooster reports exfoliated specimens of *Spirifer* sp.

SECTION ALONG THE WHITEWATER AND WALNUT RIVERS FROM TOWANDA TO WINFIELD.

There is a decrease in altitude of about 325 feet in the sixteen miles from the Summit to El Dorado in the Walnut river valley; but the country is comparatively smooth with but few exposures of rocks. From Towanda, eight miles south of west of El Dorado, in the Whitewater valley, a section was followed in the direction of the strike along the valleys of the Whitewater and Walnut rivers to Winfield, Cowley county. Four miles northwest of Towanda, on the south bank of the West Whitewater river, west side section I, Benton township, is the following section:

No.		Feet.
3.	Yellowish shales, which are 40 feet above river level	1=12
2.	Buff limestone containing gypsum concretions, some flint and specimens of *Bakevellia parva* M. and H.	1=11
1.	Yellowish argillaceous shales in the upper part and shaly limestones at the base.	10=10

The section just described, as well as the rocks between the two Whitewater rivers and to the west of Towanda and the main Whitewater river, belong in the Marion formation. On the eastern side of the river, in the vicinity of Towanda, are occasional exposures of buff limestone, but no fossils were found.

On the divide between the Whitewater and Walnut rivers, four miles north of Augusta and one-half mile west, is a small quarry in a buff, massive limestone, nine feet of which is exposed. It contains a layer of flint one inch in thickness and some fossils as: *Athyris subtilita* (Hall) Newb., *Productus semireticulatus* (Mart.) de Koninck, *Pleurotomaria* sp., *Archæocidaris* sp., and crinoid segments. The dip is southerly, and this zone seems to belong in that of the Winfield limestone.[1]

On the south bank of the Walnut river, at the highway bridge south of Augusta, is an excellent exposure of the Florence flint and limestone. The section is as follows:

No.		Feet.
4.	Shaly buff limestones, fossiliferous..............	35 – 50
3.	Argillaceous shales	
2.	Massive, buff limestone, thick bedding, and 13 feet thick in the quarry east of the highway.	
1.	Thin layers of flint, alternating with thin limestones which are somewhat fossiliferous.	15=15

River level.

From this outcrop the following species were collected:

1. *Athyris* (*Seminula*) *subtilita* (Hall) Newb.............. (r)
2. *Derbya multistriata* (M. and H.) Pros....... .... (r)
3. *Meekella*(?) *Shumardiana* (Swal.)(?)................. (rr)
4. *Productus semireticulatus* (Mart.) de Kon., var. *Calhounianus* Swal. (c)
5. *Productus semireticulatus* (Mart.) de Kon.............. (rr)
6. *Pinna peracuta* Shum................................ (rr)
7. *Aviculopecten occidentalis* (Shum.) Meek................ (rr)
8. (?) *Allorisma* sp.................................. (rr)
   Poorly preserved.
9. *Bellerophon* sp .... (rr)
   Imperfectly preserved.
10. *Campophyllum* sp.................................. (a)
11. *Chætetes* sp... (rr)
12. *Archæocidaris* spines.

For the purpose of assistance in correlation and in tracing the various limestones across the state it is important to remember that

[1] For the definition of this name see Univ. Geol. Surv. Kans., vol. II. p. 61.

the Florence limestone, so well exposed on the Cottonwood river at the city of that name, is the same as the Fort Riley limestone on the Kansas river at Fort Riley and Junction City.

On the bank of the Little Walnut creek, two miles northeast of Douglass, are shaly buff limestones, apparently in the Florence, which contain the following fossils:

1. *Athyris* (*Seminula*) *subtilita* (Hall) Newb .... (c)
2. *Derbya crassa* (M. and H.) H. and C .... (r)
3. *Derbya multistriata* (M. and H.) Pros .... (c)
4. *Aviculopecten occidentalis* (Shum.) M. and W .... (rr)
5. *Septopora biserialis* (Swallow) Waagen .... (rr)
6. *Phillipsia major* Shumard .... (rr)

From Douglass along the valley of the Walnut river to Winfield there are frequent outcrops of the Florence limestone, and near the summit of the bluffs the Winfield limestone. In a railroad cut, two and one-half miles south of Douglass, is a good exposure of the Winfield limestone and forty feet of lower shales. There are numerous small rolls shown in the cut, both anticlinal and synclinal. The section is:

No.		Feet
3.	Massive limestone which weathers rather rough and contains some fossils. No concretions at this locality. *Winfield* limestone.	11 = 51
2.	Yellowish argillaceous shales	20 = 40
1.	Variously colored argillaceous shales, greenish, maroon, yellowish, etc. Some of the maroon layers 2 feet thick. No fossils found in the shales. Railroad level.	20 = 20

These colored shales below the Winfield limestone correspond to similar shales described by the author in the Cottonwood valley below the Marion limestone, as the Winfield limestone was first called.[1] The Winfield limestone above the railroad cut, at this locality, contains the following species:

1. *Productus semireticulatus* (Martin) de Kon .... (rr)
2. *Derbya crassa* (M. and H.) H. and C. .... (c)
   Some of the specimens are near *D. multistriata* (M. and H.) Pros.
3. *Schizodus Wheeleri* (Swallow) Meek.(?) .... (rr)
4. *Archæocidaris* sp. .... (rr)
   Spines and plates.

In a small run on the south side of Rock creek, six miles south

[1] Jour. Geol., vol. iii, p. 773.

of Douglass and one mile south of Rock, is a ledge of massive, soft buff limestone, four feet of which is shown. This stratum is only three or four feet above the level of Rock creek, and by the barometer seventy feet below the Winfield limestone on the bluff to the north, and is in the Florence sub-formation; the difference of seventy feet between the two limestones being about the average thickness for the intervening shales.

About one and one-fourth miles farther south, on Spring creek, at the W. H. Grove farm, is an outcrop of ten feet of the Florence buff, massive limestone. The ledge shows plenty of "sand holes" and fragments of fossils.

Around the head of a draw on the highway, five miles north of Winfield, is an excellent outcrop of the Winfield concretionary limestone. It is a typical ledge, for it contains abundant concretions; but they are not of constant occurrence as may be readily seen by following the outcrop of this limestone from Douglass to Winfield. The limestone is coarse and rough, weathering in large, angular, whitish blocks. Below are yellowish and colored argillaceous shales; while in the upper part of the limestone, and in great numbers loose on the ground, are large iron-stained concretions containing fossils. These are known locally as "sand bricks," and they are flatter than those to the north in the Cottonwood valley, which are oblong or rounded. From this concretionary limestone the following species were collected:

1. *Productus semireticulatus* (Mart.) de Kon .... (rr)
2. *Rhombopora lepidodendroides* Meek .... (rr)
3. *Septopora biserialis* (Swallow) Waagen .... (rr)
4. *Chætetes* sp .... (rr)

A little higher on the highway may be seen plenty of loose flint, probably from the decomposition of limestone at that locality.

As nearly as can be determined from the topographic sheets and other data at command there is a dip of one hundred feet in the Florence limestone from the quarry on the Walnut river south of Augusta to the one in the eastern part of Winfield. The distance between the two localities is twenty-eight miles, which would give a south dip of about three and a half feet per mile.

Elk and Cowley Counties.

To the south of Greenwood and Butler counties are Elk and Cowley counties, Cowley extending south to the state line while to the east of its southern half and south of Elk is Chautauqua county. The eastern half of Cowley and the western part of Chautauqua

and Elk counties are in the Flint Hills, the crest of which is near the Cowley-Chautauqua and Elk county line.

For the purpose of studying the stratigraphy of the southern Flint Hills and determining their geological formations, two sections were followed from the east across them. The northern section is along the line of the Atchison, Topeka & Santa Fe railroad from Moline, Elk county, through Grenola, Grand Summit and Cambridge to Grouse creek, Cowley county. The southern one is along the Missouri Pacific railroad from the vicinity of Cedar Vale, Chautauqua county, through Hooser, Dexter and Eaton to Winfield, Cowley county.

SECTION FROM GRENOLA TO GRAND SUMMIT.

The Grand Summit section is, perhaps, the best known Permian section of southern Kansas. This is due in part to the abundant fossils found in the railroad cut east of Grand Summit station. A section of the eastern side of the Flint Hills, in this region, was described by Prof. Broadhead in 1882,[1] and the writer's attention was first directed to the locality by the fine collection of Permian and Carboniferous fossils from it in the Geological Museum in the University of Kansas. Mr. Geo. I. Adams has also described in a somewhat general way the section along the line of this railroad through Moline, Grenola and Cambridge to Winfield.[2]

In the northern part of Moline, on the bank of the Wild Cat creek, are iron-brown shaly limestones containing large numbers of *Fusulina cylindrica* Fischer and other fossils. On the hill to the northwest of the city is quite a thickness of drab to buff sandy shales, that contain but few fossils. These are capped by a thin, brownish to yellowish limestone. The rocks in the vicinity of Moline probably belong in the Wabaunsee formation.

Grenola is situated in the valley of Big Caney creek, Greenfield township, in the western part of Elk county. The railroad cut, immediately east of Grand Summit station, is five miles north of west from the bluish shales on the bank of the Big Caney creek just west of Grenola which form the base of the following section from the creek to the cut east of Grand Summit:

No.		Feet.
28.	Top of railroad cut, east of Grand Summit, yellowish to bluish shales and shaly limestones in which fossils are very abundant. An excellent locality for collecting.	15=407

1 Trans. St. Louis Acad. Science, vol. iv, pt. iii, published in 1883 or '84, pp. 486, 487.
2 Univ. Geol. Surv. Kans., vol. 1, pp. 20-29, and pl. 1.

No.		Feet.
27.	Massive, light gray limestone, which forms a conspicuous bench on the hillside. Lower part of the *Strong* limestone.	10=392
26.	Rather coarse, yellowish shales, about 15 feet.......	15=382
25.	Fine argillaceous maroon shales at top, and lower variously colored shales.	30=367
24.	Rather shaly limestone, which, in places, is very hard, 3 to 4 feet thick.	4=337
23.	Shales alternating with thin limestones; at base maroon shale.	26=333
22.	Heavy limestone at top, below shaly limestone and shales. One layer contains plenty of fossils.	20=307
	{ Nos. 22 to 28=No. 1 of Broadhead, which, in his section, is 134 feet thick. }	
21.	Limestone of bluish-drab color....................	5=287
	{ No. 2 of Breadhead's section, which he gave as 5 feet thick. }	
20.	Shales, lower part bright maroon color.............	10=282
	(No. 3 of Broadhead.)	
19.	Limestone, 10 feet thick, according to Broadhead and No. 4 of his section.	10=272
18.	Shales to shaly limestones containing fossils........	25=262
17.	Light buff-colored *Fusulina* limestone, with layer of flint.	1½=237
	{ Nos. 17 and 18=No. 5 of Broadhead, which he gave as 27 feet of shales with thin shaly limestone beds. }	
16.	Somewhat shaly *Fusulina* limestone. (No. 6 of Broadhead, which he called "a flag-like limestone bed; a good building rock.") Perhaps Nos. 16 and 17 represent the *Cottonwood* limestone.	4=235½
15.	Yellowish shales; *Fusulinas* very thick in top of shales.	5=231½
14.	Drab. Very hard limestone......................	1¾=226½
	{ Nos. 14 and 15, with probably the top of No. 13= No. 7 of Broadhead, which he gave as 8 feet shelly buff limestone. }	
13.	Yellowish soft shales; *Spirifer cameratus* and numerous other fossils.	5=224¾
	(No. 8 of Broadhead.)	
12.	Massive limestone with abundant *Fusulina*, and six inch layer of flint at top and bottom.	2=219¾
11.	*Fusulina* light gray limestone.....................	1¾=217¾
	(Nos. 11 and 12=No. 9 of Broadhead.)	

No.		Feet.
10.	Yellowish shales, *Spirifer cameratus*, *Fusulina* and plenty of fossils.	$1\frac{3}{4}$=216
9.	Light gray, massive *Fusulina* limestone, with layer of flint at top.	$1\frac{3}{4}$=$214\frac{1}{4}$
8.	Yellowish fossiliferous shaly limestone, $2\frac{1}{2}$ to 3 feet.	3=$212\frac{1}{2}$
7.	Shales and shaly limestone........................	$2\frac{1}{2}$=$209\frac{1}{2}$
6.	Covered, 10 to 11 feet...........................	10=207
	(Nos. 6 to 11=No. 10 of Broadhead.)	
5.	Massive, drab limestone..........................	2=197
	(No. 11 of Broadhead, and base of his Permian.)	
4.	Covered, except at base, where it is a cellular, shaly, yellow limestone, in front of O'Connell's house.	25=195
	(The limestone=No. 13 of Broadhead, which he gives as 4 feet thick and capped by 28 feet of shaly sandstone.)	
3.	Arenaceous yellowish shales in upper part; yellowish iron-stained limestone alternating with drab shales in lower part; in first railroad cut west of Grenola. *Spirifer cameratus*.	15=170
	(No. 14 of Broadhead, which he referred to the "true Upper Coal Measures.")	
2.	Covered, with shaly bluish limestone and shales in lower part; at first large railroad fill west of Grenola.	55=155
	(Probably Nos. 15 to 18 of Broadhead, which he gave as 52 feet in thickness.)	
1.	Covered. Bluish shales at base containing *Spirifer cameratus* and other fossils; on the western bank of Big Caney creek. (No. 19 of Broadhead; 20 feet of sandy shales in the upper part of this zone.)	100=100

Level of Big Caney creek, at highway bridge west of Grenola.

The thickness of this section agrees closely with the difference in altitude obtained from the Atchison, Topeka & Santa Fe railroad levels, which give 400 feet, although the topographic sheets give barely 300 feet. No allowance has been made for the dip, which will probably increase somewhat the total thickness of the rocks in this section, since Prof. Broadhead obtained a dip of twenty-six feet per mile to the southwest in the eastern part of Cowley county,[1] while Adams gave the dip along the line of this section as "about ten feet per mile" to the west,[2] and as stated later, the writer obtained a dip to the southwest of sixteen feet per mile.

1 Ibid., p. 488.
2 Op. cit., p. 28

CORRELATION AND PALEONTOLOGY.—For the purpose of classification it is more convenient to begin with the upper part of this section, which is readily correlated. The massive limestone—No. 27—in the railroad cut east of Grand Summit, forms the lower part of the Strong limestone at the base of the Chase formation. Above the limestone are the yellowish and bluish shales—No. 28—which contain abundant fossils. Here the larger number of fossils have been collected that are credited to Grand Summit, Cowley county. These shales correspond to the fossiliferous shales—No. 14—of the section west of Reece. The most abundant species are *Productus nebrascensis* Owen, many very perfect and beautiful specimens of which occur in great numbers; *Meekella striato-costata* (Cox) White and St. John; *Myalina Kansasensis* Shum.; and *M. Swallovi* McChesney. The following is the complete list collected in about one hour:

1. *Productus nebrascensis* Owen........................... (aa)
2. *Productus semireticulatus* (Mart.) de Kon.............. (r)
3. *Derbya multistriata* (M. and H.) Pros................. (rr)
4. *Derbya crassa* (M. and H.) H. and C................... (rr)
5. *Meekella striato-costata* (Cox) White and St. John....... (a)
6. *Athyris (Seminula) subtilita* (Hall) Newb..............
7. *Myalina Kansasensis* Shum............................ (a)
8. *Myalina perattenuata* M. and H........................ (rr)
9. *Myalina(?) Swallovi* McChesney........................ (a)
10. *Gervillia longa* Geinitz.............................. (rr)
11. *Aviculopecten occidentalis* (Shum.) M. and W........... (r)
12. *Aviculopecten* sp.
    Small specimens, apparently adult, with some smaller plications between the coarser.
13. *Pinna peracuta* Shum................................. (c)
    Part of the specimens are unusually large and possibly belong to a different species.
14. *Pseudomonotis Hawni* M. and H......................... (rr)
    Small specimens.
15. *Aviculopecten* cf. *neglectus* (Geinitz) Meek.............. (rr)
16. *Aviculopecten neglectus* (Geinitz) Meek................ (rr)
17. *Allorisma* sp... (rr)
18. *Schizodus* sp.. (a)
    Large form, in outline somewhat like *S. curtus* M. and W.
19. *Schizodus Wheeleri* (Swal.) Meek....................... (rr)
20. *Schizodus curtus* M. and W............................ (r)

21. *Straparollus* (*Euomphalus*) *subrugosus* M. and W........ (rr)
22. (?)*Nuculana bellistriata* Stevens, var. *attenuata* Meek.... (rr)
Very imperfectly preserved.
23. *Discina nitida* (Phillips) M. and W.(?)............... (rr)
24. *Discina* cf. *convexa* Shum.............................. (rr)
25. *Bellerophon* sp.................................. (rr)
Imperfectly preserved.
26. *Aclis* cf. *Swalloviana* (Geinitz) Meek................. (c)
27. *Rhombopora lepidodendroides* Meek.(?)................. (rr)
28. *Archæocidaris* spines............................ (c)
29. *Bryozoa* sp...................................... (r)
30. *Septopora biserialis* (Swallow) Waagen................ (r)
31. *Entolium aviculatum* (Swal.) Meek.(?)................ (rr)
32. *Orthoceras* cf. *rushensis* McChes.................... (rr)
33. *Crinoid* segments................................. (r)
34. *Macrodon* cf. *obsoletus* Meek......................... (rr)

The yellowish shales—No. 26—at the bottom of the massive limestone are referred to the Neosho formation, which, in the Cottonwood valley, has a zone of similar shales at its top.[1] The base of the Neosho formation, however, is not determined as easily, since the position of the Cottonwood limestone is somewhat in doubt. Ninety-five feet below the base of the Strong limestone is the top of the bluish drab limestone—No. 21 of this section and No. 2 of Broadhead's—which he described as "persistent wherever its associated strata are found," and "containing many good characteristic fossils, including *Eumicrotis* [*Pseudomonotis*] *Hawni*, *Myalina perattenuata*, *Aviculopecten occidentalis*, *etc.*" A similar limestone and fauna are in the Neosho formation in the Cottonwood valley 94 feet below the base of the Strong limestone, and a lower one 110 feet below it, so it seems probable that No. 21 is in the Neosho formation. In the Cottonwood and Kansas valleys it is 144 feet from the bottom of the Strong limestone to the top of the Cottonwood limestone. In the Grand Summit section, without a complete allowance for dip, it is 145 feet from the bottom of the Strong limestone—No. 27—to the top of No. 17, the light buff-colored Fusulina limestone. In the railroad cut this limestone does not resemble the Cottonwood limestone in texture, for it consists of a layer one and a half feet thick at the top, with a shaly Fusulina limestone four feet thick at the base; but there is an agreement in color and the great abundance of Fusulinas. When this zone was first studied it was referred to the horizon of the Cot-

1 Jour. Geol., vol. III, p. 765, No. 16 of the section.

tonwood limestone, although it does not closely resemble it as shown in its typical region, and furthermore the underlying rocks do not agree with those below the Cottonwood limestone in the Cottonwood valley. However, after a consideration of all the data at hand, it appears to correspond more nearly with the Cottonwood than with any of the other limestones in that part of this section where we may expect to find its horizon. The limestone is light gray to whitish in color, unless stained, and contains myriads of Fusulina with a few fragments of shells. The flint is more abundant than in the Cottonwood limestone farther north, and in this are abundant specimens of Fusulina.

The shales and shaly limestones—No. 18—overlying this limestone are somewhat fossiliferous, the following species having been obtained:

1. *Productus cora* d'Orbigny.......................... (c)
2. *Productus nebrascensis* Owen.......................... (rr)
3. *Allorisma subcuneatum* M. and H.................. (rr)
4. *Aviculopecten occidentalis* (Shum.) M. and W........... (rr)

These shales do not agree in reference to the fauna with the yellowish, very fossiliferous shales which overlie the Cottonwood limestone in the central and northern parts of Kansas. Perhaps they represent the Cottonwood shales and with the subjacent limestone constitute the Cottonwood formation which will then have a thickness of 30½ feet in this section.

If the correlation of Nos. 16 and 17 of the above section, with the Cottonwood limestone, be correct, then the remaining 231 feet of the section commencing with No. 15 belong in the Wabaunsee formation. Nos. 12 and 9 are massive, light gray limestones, which also contain large numbers of Fusulina and great quantities of flint, especially No. 12 in which there is a conspicuous six inch layer of flint at the top and bottom of the stratum. In fact these limestones contain the greatest amount of flint seen in any part of the section, for in the Strong limestone or flint but a comparatively small amount of flint was seen.

The yellowish shales alternating with these Fusulina limestones contain plenty of fossils, *Spirifer cameratus* Mort. occurring frequently in them; but it was not noticed above the limestone which is referred to the Cottonwood. The shales of No. 13 furnished the following species:

1. *Spirifer cameratus* Mort............................ (r)
2. *Spirifer* (*Martinia*) *planoconvexus* Shum............... (r)
3. *Athyris* (*Seminula*) *subtilita* (Hall) Newb............. (r)

4. *Productus cora* d'Orbigny.......................... (r)
5. *Derbya robusta* (Hall) H. and C.(?).................. (rr)
   Similar to fig. 17, pl. X, Pal. N. Y., Vol. VIII, Pt. II.
6. *Derbya crassa* (M. and H.) H. and C.................. (rr)
7. *Septopora biserialis* (Swallow) Waagen................ (c)
8. *Meekella striato-costata* (Cox) White and St. John...... (rr)
9. *Rhombopora lepidodendroides* Meek.................... (rr)
10. *Fistulipora nodulifera* Meek.......................... (rr)
   A flat specimen which apparently belongs to this species.
11. *Crinoid* segments.................................. (c)

In No. 10 the seven species of the succeeding list were obtained:

1. *Spirifer cameratus* Morton............................ (c)
2. *Athyris* (*Seminula*) *subtilita* (Hall) Newb............... (rr)
3. *Productus cora* d'Orbigny............................ (rr)
4. *Chonetes granulifera* Owen............................ (c)
5. *Fusulina cylindrica* Fischer............................
   Abundant in layers.
6. (?)*Fistulipora nodulifera* Meek......................... (rr)
7. *Meekopora Prosseri* Ulrich........................... (c)
   Identified by Ulrich and described in MS.

From the bluish shales at the base of No. 1, on the bank of Big Caney creek, the following species were collected after a hasty search:

1. *Spirifer cameratus* Mort............................ (c)
2. *Productus cora* d'Orbigny............................ (rr)
3. *Productus nebrascensis* Owen.......................... (rr)
4. *Aviculopecten carboniferus* (Stevens) Meek............. (rr)

Prof. Broadhead regarded No. 11 of his section—No. 5 of mine—as "undoubtedly of *Permian* type and the strata may be considered Permian,"[1] while I would locate provisionally the base of the Permian some sixty feet higher, perhaps at the top of No. 18, which equals No. 5 of Broadhead.

CAMBRIDGE SECTION.

The Strong limestone may be readily followed from Grand Summit to the southwest along the Cedar creek valley to Cambridge and the Grouse creek valley. At various places along the Cedar creek valley or its bluffs it forms a prominent ledge, and about one-fourth mile west of Cambridge is an extensive quarry in the lower part of the Strong limestone. In the Grand Summit cut the base

1 Op. cit., p. 487.

of the Strong limestone is 1429 feet A. T., while in the Cambridge quarry, nine miles to the southwest, it is approximately 1284 feet A. T., giving a dip to the southwest of 16 feet per mile.

Section of the Cambridge quarry:

No.		Feet.
4.	Yellowish and bluish shales which contain some fossils.	$4=52\frac{1}{4}$
3.	Hard limestone, containing numerous fossils, especially *Pleurophorus.*	$\frac{3}{4}=48\frac{1}{4}$
2.	Massive, hard limestone, used for building stone, which, in the eastern part of the quarry, contains a considerable amount of flint. There is also quite a large amount of loose flint on the surface near the quarry.	$2\frac{1}{2}=47\frac{1}{2}$
1.	Covered..................................	$45=45$

Level of Grouse creek.

From Nos. 3 and 4—the larger number from No. 3—the following species were obtained:

1. *Pleurophorus subcostatus* M. and W.(?)............... (c)
   These specimens are not so large as the figures in the Illinois report and are probably the form mentioned as a variety of *P. subcuneatus* M. and H. (Geol. Surv. Ill., Vol. II, Palæontology, p. 348).
2. *Pleurophorus*(?) *Calhouni* M. and H.(?)............... (aa)
   A considerable number of gibbuns specimens, which agree fairly well with the figures and description of this species. In some of the specimens there is a longitudinal depression posterior of the umbones, which probably represents the lateral tooth.
3. *Yoldia*(?) *subscitula* M. and H........................ (rr)
4. *Pleurophorus*(?) *subcuneatus* M. and H................ (c)
5. *Pseudomonotis Hawni* (M. and H.).................... (c)
6. *Pseudomonotis Hawni* (M. and H.) cf. var. *ovata* M. and H. (c) and perhaps var. *sinuata* M. and W.
   Small and imperfect specimens.
7. (?)*Nautilus eccentricus* M. and H...................... (aa)
   These specimens are apparently this species, though it is possible they may belong to the genus *Bellerophon*, as they are all internal impressions.
8. *Myalina permiana* (Swal.) M. and H................. (c)

SECTION ACROSS THE SOUTHERN FLINT HILLS.

The section across the Flint Hills of the southern and central

part of Cowley county, along the line of the Missouri Pacific railroad, from Taussig at their eastern foot to Winfield in the Walnut river valley, was hastily examined. The author regrets that on account of the limited time at his disposal he was unable to determine the limits of all the formations shown in this section; but submits the following partial correlation. Mr. C. N. Gould has published a section along the line of this railroad in which the lithologic character and thickness of the rocks composing it are given;[1] but the total thickness of limestones reported in it seems to be too great.

SECTION FROM TAUSSIG TO HOOSER.

No.		Feet.
13.	Massive limestone weathering whitish and containing an abundance of flint, about 40 feet thick. Probably the *Strong limestone.*	40=435
12.	Red and blue shales, according to Gould..........	10=395
11.	Brownish sandstone, given by Gould as 10 feet thick.	10=385
10.	Mainly red shales	20=375
9.	Limestone, with abundant *Fusulina* in lower part...	5½=355
8.	Covered; about 4½ feet........................	4½=349½
7.	Light gray, rather massive limestone, containing some *Fusulina.*	5=345
6.	Mainly covered along the railroad. At base a massive limestone with a metallic ring. The central and upper part of the stratum weathers to a very rough surface. It contains a considerable amount of flint.	150=340
5.	Mainly covered; the shales at the top below the massive limestone of No. 6 contain numerous specimens of *Spirifer cameratus* and *Athyris subtilita.*	85=190
4.	Brownish limestone in which there are large numbers of *Fusulina.*	10=105
3.	Yellowish shales in which *Spirifer cameratus* and *Athyris subtilita* are common.	12=95
2.	Covered, with brownish-red *Fusulina* limestone at the base.	23=83
1.	Covered to Taussig railroad station..............	60=60

The measurements in the above section are nearly all barometric and it deserves more careful study. If the correlation of the massive limestone—No. 13—near Hooser with the Strong limestone be correct, then the horizon of the Cottonwood limestone is in the covered part of No. 6, below which all the remaining rocks belong

1 Univ. Geol. Surv. Kans., vol. I, pp. 31 to 35, and see pl. I.

in the Wabaunsee formation. The yellowish shales of No. 3 contain the species listed below:

1. *Productus cora* d'Orbigny .... (c)
2. *Productus nebrascensis* Owen .... (rr)
3. *Athyris* (*Seminula*) *subtilita* (Hall) Newb .... (c)
4. *Spirifer cameratus* Mort .... (c)
5. *Aviculopecten occidentalis* (Shum.) M. and W .... (rr)
6. *Aviculopecten* sp .... (rr)
7. *Fusulina cylindrica* Fisher .... (c)
   Abundant in shales and brownish *Fusulina* limestone.
8. *Meekopora Prosseri* Ulrich .... (rr)

DEXTER SECTIONS.

Along the railroad track from a short distance north of Dexter to the third railroad cut, one and a fourth miles south of Dexter, is the following section. The altitudes were obtained by means of a barometer and the difference between them is less than the actual thickness of the rocks, on account of the strong east dip at this locality:

No.		Feet.
5.	Heavy limestone with plenty of flint and nodules, in third railroad cut south of Dexter. The limestone contains large numbers of flat to irregular shaped concretions which are quite similar to those in the Strong limestone south of Cottonwood Falls. In the fold in the cut the dip is 5° east. Base of *Strong limestone.*	
4.	Yellowish shales with abundant fossils, then covered; below which, in the second railroad cut, are shaly limestones containing *Pseudomonotis Hawni* and three species of *Myalina.*	30=100
3.	Red and yellowish shales	15=70
2.	Yellowish to grayish shales and thin limestones containing abundant fossils, in first railroad cut half mile south of Dexter. Below is a rough limestone, and then covered to north of the Dexter station.	55=55
1.	In railroad ditch north of Dexter is shown the upper part of a massive light gray to whitish limestone, which contains great numbers of *Fusulina*, with some *Crinoid* segments and spines of *Archæocidaris.* This resembles the Cottonwood limestone considerably.	

From the yellowish shales in the third railroad cut, at the top of No. 4, the following fossils were collected:

1. *Derbya multistriata* (M. and H.) Pros................ (rr)
2. *Productus nebrascensis* Owen......................... (rr)
3. *Pinna peracuta* Shum.................................. (rr)
4. *Aviculopecten* sp..................................... (rr)

In the shaly limestones at the base of No. 4, in the second railroad cut, and in the yellowish to grayish shales at the top of No. 2, in the first railroad cut, is an abundant fauna of the Neosho formation. The list is as follows:

1. *Productus nebrascensis* Owen......................... (aa)
2. *Productus cora* d'Orbigny............................. (rr)
3. *Aviculopecten occidentalis* (Shum.) M. and W........... (a)
4. *Pseudomonotis Hawni* (M. and H.)...................... (c)
5. *Pseudomonotis*(?) sp.................................. (rr)
   Large pustules on the surface differing from any of the figures seen.
6. *Myalina Kansasensis* Shum............................ (c)
7. *Myalina perattenuata* M. and H....................... (c)
8. *Myalina*(?) *Swallovi* McChes......................... (rr)
9. *Pinna peracuta* Shum................................. (rr)
10. (?)*Astartella vera* Hall............................. (rr)
11. *Macrochilina angulifera* White(?).................... (rr)
12. *Bellerophon* sp...................................... (rr)
    Too imperfectly preserved for identification.
13. *Lamellibranch*....................................... (rr)
    Undetermined species.

The massive flint and concretionary limestone—No. 5—at the top of the above section is the base of the Stong limestone, below which is the Neosho formation; while possibly the light gray *Fusulina* limestone of No. 1 represents the Cottonwood limestone. On the western side of Grouse creek, at Dexter, the base of the Strong flint is 135 feet above the creek level; but the creek banks are covered by alluvial deposits, so that we were unable to find any exposures of rocks near the horizon of the Cottonwood limestone. In a railroad cut at Sliding Bluffs, on the western side of Grouse creek, two and one-half miles west of north of Dexter, is an excellent exposure of the lower part of the Strong limestone and subjacent shales. The flint shows prominently in the limestone and below it are yellowish shales and shaly limestones in which fossils are abundant, especially *Derbya multistriata* (M. and H.) Pros. The other species are:

1. *Derbya crassa* (M. and H.) H. and C.
2. *Productus nebrascensis* Owen.

3. *Aviculopecten occidentalis* (Shum.) Meek.
4. *Myalina Kansasensis* Shum.
5. *Pinna* sp.
   Curved and markings differing from *P. peracuta* Shum.
6. *Allorisma* (*Sedgwickia*) cf. *granosum* (Shum.) Meek...... (rr)
   Does not show granules, but outline and other markings like this species.

Below these rocks are red shales. Farther west, in the railroad cut not far east of Eaton, is a massive, buff limestone, the thick layers considerably shattered, which underlies the plateau of this region. One and one-half miles east of Eaton is the base of a massive flint limestone. This flint and the superjacent limestone are referred to the Florence flint and limestone of the Chase formation.

WINFIELD SECTIONS.

The Florence limestone can probably be followed west across the country from Eaton to the valley of the Walnut river at Winfield, as stated by Mr. Gould.[1] To the east of the Southern Kansas railroad, in the eastern part of Winfield, is a quarry in massive, buff, soft limestone which has been worked quite extensively. The lower part of the limestone is laminated; in the upper part are many "sand holes," and portions of the rock are bluish to lead color. It resembles closely the Jones quarry at Florence, and it is clearly the Florence limestone. The following section was measured from the base of this quarry, which is about on a level with the Missouri Pacific railroad station to the top of the hill just east of the Southwest Kansas College:

No.		Feet.
5.	Loose on the top of the hill just east of the Southwest Kansas College. Rough blocks of the Winfield limestone.	
4.	Massive limestone immediately east of the college. *Winfield limestone.*	
3.	Mainly covered................................	88=100
2.	Shaly yellowish limestone in upper part of quarry with *Athyris subtilita.*	2+=12
1.	Massive, buff limestone of quarry, 9½ feet exposed. *Florence limestone.*	9½=9½

The Winfield limestone, which caps the college hill to the east of Winfield, also forms the top of asylum hill to the north and reservoir hill to the south. The dip of the Florence limestone in

1 Ibid., p. 34.

the Winfield quarry is ½° south, 80° west. According to the Burden sheet, of the United States Topographic Map, the altitude of the Florence limestone at Eaton is approximately 1,375 feet A. T., while at Winfield it is 1,117 feet, and the distance between the two localities eleven miles, which will give a dip to the west of twenty-three feet per mile. In the Winfield section it is ninety feet from the base of the Winfield limestone to the top of the massive Florence limestone; while in the typical region of the Cottonwood valley it is eighty-four feet.

On the western bank of the Walnut river, to the west of Winfield, is a massive limestone which forms in places a marked escarpment along the bluff with a vertical wall of rock ten feet in thickness. Along the highway, directly west of Winfield, the ledge is thirteen feet thick, the base of which is about forty-five feet above the river level. The lower part of the ledge, when weathered, is very rough with some concretions; near the middle are yellowish shales containing numerous specimens of *Athyris subtilita* and *Derbya crassa*, with a few other species; then comes massive limestone again, above which are yellowish shales. It is a clear exposure of the Winfield limestone, except that at this locality the concretions which are so prominent at many places as, for example, five miles north of the city are inconspicuous. The following species were collected in this highway cut:

1. *Athyris* (*Seminula*) *subtilita* (Hall) Newb. . . . . (a)
   One specimen shows the spire very nicely.
2. *Productus semireticulatus* (Mart.) de Kon. . . . . (r)
3. *Productus semireticulatus* (Martin) de Kon. var. *Calhounianus* Swallow. (rr)
4. *Derbya crassa* (M. and H.) H. and C. . . . . (c)
5. *Pseudomonotis Hawni* (M. and H.). . . . . (rr)
6. *Aviculopecten occidentalis* (Shum.) Meek. . . . . (r)

The difference in altitude between the base of the Winfield limestone on college hill and on the bluff west of the Walnut river is approximately seventy-five feet, while the distance is about two and a half miles, which gives a dip to the west across the Walnut valley of thirty feet per mile.[1]

ARKANSAS CITY SECTIONS.

Twelve miles south of Winfield in the valley, between the Arkansas and Walnut rivers, is Arkansas City. To the east of the Walnut river, at the middle bridge, is a quarry in massive lime-

1 In vol. II. p. 65. of the Univ. Geol. Surv. of Kansas, the writer gave the dip as forty feet per mile across this valley; but that estimate was too great.

stone twelve feet thick which has been quarried to a considerable extent for local use. This bluff affords the best section in the vicinity of Arkansas City.

SECTIONS OF THE BLUFF EAST OF ARKANSAS CITY.

Near top of hill.

No.		Feet.
11.	Thin bedded limestones, quarried to some extent...	12=107
10.	Shales, 3 to 4 feet	3=95
9.	Limestone stratum	1=92
8.	Covered, slope	20=91
7.	Massive limestone, containing large numbess of clay pebbles, giving the stone a mottled appearance.	3=71
6.	Shales, about 7 feet	7=68
5.	Yellowish shales, exposed on bluff above quarry....	3=61
4.	Buff to blue thin limestones	5=58
3.	Shaly light gray limestone, in which fossils are abundant from 1 to 1½ feet thick.	1=53
2.	Massive limestone of quarry	12=52
1.	Covered to level of the Walnut river	40=40

Nos. 1 to 5, inclusive, of the above section are exposed in the bluff at the quarry and were measrued by Mr. J. W. Beede; while the remaining part of the section is on the hill a short distance to the southeast, for part of the details of which I am indebted to Mr. C. N. Gould. In the shaly limestone of No. 3 Mr. Beede collected the following fauna:

1. *Myalina aviculoides* M. and H. (c)
2. *Myalina* sp (c)
   Perhaps *M. recurvirostris* M. and W. Too poorly preserved for specific identification.
3. *Athyris* (*Seminula*) *subtilita* (Hall) Newb. (aa)
4. *Productus semireticulatus* (Mart.) de Kon (a)
5. *Productus semireticulatus* (Mart.) de Kon., var. *Calhounianus* Swallow. (r)
6. *Productus nebrascensis* Owen(?) (rr)
   A large specimen possibly belonging to this species, though it is wider on the hinge line and in this respect more closely resembles *P. semireticulatus.*
7. *Derbya crassa* (M. and H.) H. and C. (aa)
8. *Derbya multistriata* (M. and H.) Pros. (c)
   Perhaps some of the preceding species should be listed as this one. They are rather larger than the ordinary *D. crassa.*

9. *Aviculopecten occidentalis* (Shum.) Meek................ (rr)
10. *Rhombopora lepidodendroides* Meek.................... (r)
11. *Septopora biserialis* (Swallow) Waagen................ (rr)
12. *Pinna peracuta* Shum.............................. (rr)
13. *Edmondia subtruncata* Meek.(?)...................... (rr)
14. *Chænomya Cooperi* M. and H.(?)...................... (rr)
  Broken specimen, impossible to identify specifically.
15. *Crinoid*, calyx and numerous segments of the stem......
16. *Archæocidaris*, plates and spines..................... (c)
17. *Metacoceras dubium* Hyatt(?)........................ (rr)
  Specimen identified by Prof. Hyatt.

It seems probable that No. 2 of this section is the Winfield limestone, though it was not traced by the writer from Winfield to Arkansas City, and scarcely any flint or concretions were found at this locality.

SECTIONS NORTH AND NORTHWEST OF ARKANSAS CITY.

On the hill, two miles north of the city, Mr. Beede measured the following section belonging in the Marion formation:

No.		Feet.
3.	Shaly and hard limestones........................	8=40½
2.	Limestones containing fossils....................	7½=32½
1.	Blue shales......................................	25=25

In the limestone of No. 2 Mr. Beede collected the following fossils:

1. *Myalina aviculoides* M. and H......................... (c)
2. *Aviculopecten occidentalis* (Shum.) Meek................ (r)
3. *Bakevellia parva* M. and H........................... (c)
4. *Schizodus curtus* M. and W.(?)....................... (rr)
5. Gastropod cf. *Murchisonia* sp. or *Loxonema* sp.......... (rr)
  Internal impression showing at least ten whorls. The largest Gastropod seen in the Marion.
6. *Bryozoan* sp... (r)
  Poorly preserved.

On the eastern side of the Arkansas river, about two and a half miles northwest of Arkansas City, is a buff, soft limestone which has been quarried to some extent. This outcrop of the Marion formation is near the "head gates" of the canal where the following section was measured:

No.		Feet.
3.	Yellowish shales................................	7=42

No.		Feet.
2.	Buff, fairly massive limestone, which has a cellular layer near the center of the stratum that contains numerous specimens of *Bakevellia parva* M. and H. and an occasional specimen of *Myalina aviculoides* M. and H.(?), and *Nautilus eccentricus* M. and H.(?), both of the latter imperfectly preserved.	15=35
1.	Covered to level of Arkansas river................	20=20

Conclusion.

It is thought that the above sections will give some idea of the interesting Upper Carboniferous and Permian formations in southern Kansas which are worthy of careful study. On correlating them with the typical Permian and Upper Carboniferous formations of central Kansas it is found that in general there is a close agreement between the different zones of the several formations, except in the case of the Cottonwood formation. The abundant fauna of the lower Cottonwood shales was not found in these sections, and the horizon of the Cottonwood limestone is in some doubt. However, a more careful study of the region where the Cottonwood formation is to be expected may remove this apparent difference, since in two of the general sections studied its horizon seems to have been covered.

To the south, in Oklahoma, scarcely anything has been published about the geology of the Upper Carboniferous and Lower Permian, and it is a region which will probably afford us most interesting information when it is thoroughly studied. This investigation should be continued across Oklahoma to northern Texas at the earliest opportunity, in order to make it possible to correlate precisely the Kansas with the Texas Permian. Also, as the writer has stated elsewhere,[1] this work is necessary before a decision can be reached as to whether the Red-beds or Cimarron series of southern Kansas and northern Oklahoma should be correlated with the Permian or the Triassic.

1 Univ. Geol. Surv. Kans., vol. II, p. 9.

Range and Distribution of the Mosasaurs, With Remarks on Synonymy.

BY S. W. WILLISTON.

With Plate XX.

The Mosasaurs are at present known from four remote regions of the world—North and South America, Europe and New Zealand. Doubtless they lived over the greater part of the earth and may be expected to be found wherever the deposits in which they occur are found. Their geological range is confined exclusively to the Upper Cretaceous, from the time corresponding to the upper part of the Dakota to that of the lower part of the Laramie, or from Upper Cenomanian to the Lower Danian. The correlation of the American Cretaceous deposits with those of Europe, or even with each other is by no means exact, or even approximately exact. Nevertheless the equivalency of the different strata and epochs is sufficiently well determined to admit of approximate results, and it is one of the purposes of this paper to bring what evidence the Mosasaurs—typical Cretaceous reptiles—may present, bearing upon the subject.

The oldest Mosasaurs are apparently those described by Hector from New Zealand, which he referred to the genera Liodon and *Taniwhasaurus* Hector.* The genus *Liodon* Owen, Dollo has recently shown to be a synonym of *Mosasaurus*.† Whether or not Hector's species is congeneric with those placed under *Liodon* by Cope is not certain, though it is evident that it is closely allied. *Taniwhasaurus* is as clearly of the *Platecarpus* type, and may possibly belong to that genus.

The most recent form is the historical *Mosasaurus giganteus* Soemmering (*M. Camperi*, *M. Hoffmani*) from the Mæstricht beds in the Lower Danian. These three forms, *Tylosaurus*, *Platecarpus* and *Mosasaurus* represent three distinct and divergent types, which I will call the Tylosaurinæ, Platecarpinæ, and Mosasaurinæ, cor-

*On the Fossil Reptilia of New Zealand, Trans and Proc., New Zealand Institute, vi. 338. 1873.
†Bull. Soc. Belg. Geol., vii, 79. 1892.

responding to the megarhynchous, microrhynchous and mesorhynchous types of Dollo.*

The Tylosaurinæ begin with *Liodon* (*Tylosaurus?*) *Haumurensis* Hector in the Cenomanian of New Zealand and continue to the Upper Senonian of Belgium as found in the genus *Hainosaurus* Dollo, from the Brown Phosphatic Chalk of Mesvin Cipley. In the interior of North America the type, so far as known, begins near the lower part of the Niobrara and terminates at its close or in the beginning of the Ft. Pierre, that is, to use the European time periods, with the close of the Turonian or the beginning of the Senonian. Forms ascribed to this genus, the *Liodon* of Cope, are from the Lower Greensand or Lower Marl of New Jersey, but their positive identification is yet uncertain, if not doubtful, since the only characteristic parts, the rostrum, quadrate and limb bones have never yet been found. There is nothing improbable in its occurrence in these beds, but hitherto nothing decisively characteristic of *Tylosaurus* has been found there. The genus *Hainosaurus* is clearly of the *Tylosaurus* type. In fact the two genera are so nearly related that decisive distinctional characters are not yet forthcoming, unless they be found in the paddles.

The Platecarpinæ have a very similar distribution. Beginning in the Cenomanian of New Zealand, in *Taniwhasaurus*, if the deposits of New Zealand are really cotemporaneous with this epoch in Europe, they terminate in the closely allied *Plioplatecarpus* Dollo from the Lower Mæstrichtian of Belgium. In North America the species upon which the genus *Platecarpus* has been chiefly based are known nowhere outside of Kansas and Colorado, and are here restricted exclusively to the Niobrara. The type species of this genus, *P. tympaniticus* Cope, is from Mississippi and is in all probability congeneric with the Kansas species, but this has not yet been satisfactorily proven, though it certainly belongs in the Platecarpinæ.

From the Ft. Pierre only one species can be referred to this group, and this with doubt. *Brachysaurus* described by myself in the last number of this QUARTERLY may belong here, but I believe that its affinities are more close with the Mosasaurinæ. It is certainly closely related to *Prognathosaurus* Dollo,† from the Upper Senonian of Belgium, and I should have had little hesitancy in identifying it with that genus had not Dollo stated that the chevrons are free in *Prognathosaurus*.‡

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*Mem. Soc. Belg. de Geol., iv, 163, 1890.
†Mem. Soc. Belg. de Geol., iii, 193, 1889.
‡Mem. Soc. Belg. de Geol., iv, 163, 1890.

Of the Mosasaurinæ, including the two genera *Mosasaurus* and *Clidastes*, the lowest horizon is the upper part of the Niobrara in Kansas. *Clidastes* ranges into the Ft. Pierre, as previously stated by myself. In the eastern Atlantic region his genus is represented by forms closely allied to those from Kansas. Its range then, is from the upper part of the Turonian through the larger part of the Senonian.

The typical *Mosasaurus* is confined exclusively to the Senonian and Danian. Its distribution in North America is reputed to be from New Jersey, Alabama and Dakota, but some of the determinations may be incorrect. The species from the Ft. Pierre are, however, clearly congeneric with one or more from New Jersey. In Europe *Mosasaurus* is known only from the Upper Senonian and the Danian (Upper Chalk and Mæstrichtian), that is, apparently, from later horizons than those in which the genus occurs in America.

The two genera *Mosasaurus* and *Clidastes* are nearly related, though sufficiently different to justify their independent existence.

From the known distribution of the Mosasaurs, Dollo has concluded, "Que la Nouvelle-Zéland (ou, mieux, les terres australes) est le centre d'irradiation des Mosasauriens, qui en seraient partis à la fin de l'époque cénomanienne, auraient vécu uniquement en Amérique durant l'époque turonienne, auraient émigré en Europe à l'époque sénonienne et s'y seraient éteints avec l'époque mæstrichtienne." The fact that Mosasaurs are reported from the Amazonian Purus, corresponding to the Mæstrichtian, would certainly indicate that they had not become at all restricted in distribution in the latter part of their existence.

The distribution of the Mosasaurs, so far as now known, seems to be of little value in the correlation of the Cretaceous epochs. Only a single genus seems to be of wide distribution, and the nearly related ones may be widely separated in geological range. Two, perhaps three distinct types appear suddenly in the Cenomanian and have continued side by side in the same waters throughout the greater part of the time during which the group has been in existence. Some minor divergent forms have appeared, such as the singular *Phosphorosaurus* Dollo, *Prognathosaurus* and *Brachysaurus* and, perhaps, *Baptosaurus* Marsh, which, by the way, is one of the latest American forms, from the Upper Greensand or Marl of New Jersey, and occurring also, if Merriam's determination is correct, in the Niobrara of Kansas.

The common aquatic ancestor of the three types must be sought for in a much earlier period, certainly in the Lower Cretaceous.

The rudimentary or possibly functional zygosphene among the Platecarpinæ, or some members of it and the complete zygosphene in *Clidastes*, together with the shortened muzzle and more fully ossified paddles, indicates a much closer relationship between the Platecarpinæ and Mosasaurinæ than between either and the Tylosaurinæ. In the last we find, in some forms at least, that the fifth finger is actually longer than the fourth, with as many phalanges, and that the carpus and tarsus are almost wholly unossified. If we assume with Dollo that the zygosphene is a primitive character, and it must be unless it had an independent origin among the Mosasaurs, then *Clidastes* would be the most generalized and *Tylosaurus* the most specialized of the Mosasaurs. In the paddles and skull, *Tylosaurus* is with hardly a doubt, more specialized than any other genus. However, although *Clidastes* may retain some of its primitive characters, it certainly shows in many other respects a high degree of specialization.

In the accompanying plate are shown the side views of skulls of two of these types, the Tylosaurinæ and Platecarpinæ. The third type, the Mosasaurinæ, may be seen by reference to plate XV, in Vol. III, of this QUARTERLY.

I give below a tabular review of the known genera of the Mosasaurinæ arranged in systematic sequence, using the European time-epochs for comparison's sake. Of course it is understood that the exact equivalency of these time-periods is yet a matter of uncertainty.

TYLOSAURINÆ.

Hind feet functionally pentadactylate. Trunk short, the tail proportionally long, not dilated distally. Tarsus and carpus almost wholly unossified, the phalanges numerous. Vertebræ wholly without zygosphene. Premaxillary projecting into a long rostrum in front of the teeth. Quadrate with a short suprastapedial process.

Tylosaurus Marsh.

Cenomanian of New Zealand (*Liodon Haamuriensis* Hector).
Upper Turonian of Kansas and New Mexico (Niobrara).
? Senonian of New Jersey (Greensand).

Hainsosaurus Dollo.

Upper Senonian of Belgium (Brown Phosphatic Chalk of Cipley).

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*Mem. Soc. Belg. Geol., iv. 168.
†Ueber the Pythonomorphen der Kansas Kreide. Paleontographica, xli. 35.

PLATECARPINÆ.

Hind feet functionally pentadactylate. Trunk short, the tail proportionally long, not dilated distally. Carpus and tarsus imperfectly ossified. Vertebræ with rudimentary or functional zygosphene. Premaxillary not projecting beyond the teeth, very obtuse. Quadrate large, with long suprastapedial process.

Platecarpus Cope.

Upper Turonian of Kansas and Colorado (Niobrara).

? Senonian of Mississippi.

Plioplatecarpus Dollo.

Lower Mæstrichtian of Belgium (Danian).

Prognathosaurus Dollo.

Upper Senonian of Belgium (Brown Phosphate of Cipley).

? **Brachysaurus** Williston.

Senonian of Dakota (Ft. Pierre).

Sironectes Cope and Holosaurus Marsh.

Upper Turonian of Kansas (Niobrara).

Taniwhasaurus Hector.

Upper Cenomanian of New Zealand.

MOSASAURINÆ.

Hind feet tetradactylate. Carpus and tarsus fully ossified, and with not more than six phalanges in any digit. Trunk relatively long, the thorax short, the tail much compressed distally, the chevrons co-ossified with the centra. Zygosphenes rudimentary or functional. Humerus with a strong radial process at distal end. Prefrontal more or less dilated into a horizontal plate posteriorly. Coronoid large. Rostrum short, obtusely conical. Quadrate small, with a suprastapedial process of moderate length.

Mosasaurus Conybeare.

Lower Danian of Belgium and England (Upper and Lower Mæstrichtian and Upper Chalk).

Upper Senonian of Belgium (Brown Phosphate of Cipley).

Senonian of New Jersey and Dakota (Greensand and Ft. Pierre).

? Senonian of Alabama and North Carolina.

Clidastes Cope.

Uppermost Turonian or Lowermost Senonian of Kansas and Colorado (Niobrara and Ft. Pierre).

Senonian of New Jersey, Alabama and Mississippi.

INCERTÆ SEDIS.

Baptosaurus Marsh.

Upper Senonian of New Jersey (Upper Greensand).
Upper Turonian of Kansas (Niobrara).

Phosphorosaurus Dollo.

Upper Senonian of Belgium (Brown Phosphatic Chalk of Cipley).

TYLOSAURUS.

? *Macrosaurus* Owen, Journ. Geol. Soc. Lond., 1859, 380.

? *Lesticodus* Leidy, Proc. Amer. Phil. Soc., 1859, vii, 10.

? *Nectoportheus* Cope, Proc. Amer. Phil. Soc., 1868, 181.

Liodon Cope et alia, nec Owen.

Rhinosaurus Marsh, Amer. Journ. Sci., June, iii, 461, 1872 (preoc.).

Rhamphosaurus Cope, Proc. Acad. Nat. Sci. Phil., 1872, 141 (preoc.).

Tylosaurus Marsh, Amer. Journ. Sci., iv, 1872, 147.

Moderate to very large sized species. Rostrum much produced, the nares situated far back. Facial surface of the parietal produced to the posterior part in the middle, the sides nearly parallel. Postfrontal and prefrontal meeting on the superior orbital border. Prefrontal not expanded on the facial plane over the orbit. Quadrate with a short suprastapedial process. Humerus slender, the proximal end angular, the distal end without radial process. Ulna and radius slender. A single carpal or tarsal bone present, not articulating with adjacent bones. Phalanges very numerous, the fifth finger not reduced. Hind limb as large as the anterior. Spines of caudal vertebræ not elongated. Thoracic vertebræ twelve to fourteen in number, the lumbo-dorsals about ten, the pygal caudals five; whole number of vertebræ not exceeding one hundred and twenty; no zygosphene. Coracoid not emarginate.

As in *Platecarpus* the rightful name of this genus can not be determined until more is known about the forms described from incomplete material from New Jersey. It seems very probable that the name *Tylosaurus* will eventually have to be abandoned. It is altogether likely that *Nectoportheus* is the same, while *Macrosaurus* and *Lesticodus* possibly are. In this uncertainty *Tylosaurus* may be retained for the present.

Macrosaurus lævis Owen, the type of the genus, was proposed for a species represented by two dorsal vertebræ from the Greensand of New Jersey. Leidy (Cretaceous Reptilia, 75) referred other remains to the same species, but with the remark, "I cannot

avoid the suspicion that both the specimens in question and those described by the high authority just mentioned (Owen) really appertain to the dorsal series of *Mosasaurus*." The vertebræ figured by Leidy seem to be congeneric with the Kansas forms referred to *Tylosaurus*, but, inasmuch the genus is distinguished with difficulty by the vertebræ alone, it would be hazardous to say with any degree of certainty that they are really the same. Cope, in 1870 (Extinct Batrachia, etc.), referred certain bones to this same species under the name *Liodon*. In the plates of the same work he figured two or three vertebræ over the name of *L. validus*, referred to *L. lævis* in the text, and to *Clidastes antivalidus* in the explanation of the plates! The bone figured in the text certainly does not belong with *Tylosaurus*, and, if Cope is correct in his determination, *Macrosaurus* is not the same as *Tylosaurus*. The different names that he used, however, are sufficient evidence of his uncertainty.

Lesticodus was given by Leidy to a species (*L. impar*) represented by teeth and portions of the jaws, and was afterwards abandoned by him. Cope apparently believed that the genus was the same as *Liodon* Cope.

Nectoportheus Cope was based upon *Liodon validus* (olim *Macrosaurus*) and was characterized by him as follows: (Extinct Batrachia, etc., 208) "The posterior dorsals are so much more depressed than in *Liodon lævis*, that future discovery may justify the generic separation of the genus *Nectoportheus*, which I originally applied to this animal." In his "Cretaceous Vertebrata" (p. 160) he says: "The typical species of this genus (*Liodon anceps* Owen) is very little known, but few remains having been obtained from the English chalk, its locality and horizon. Numerous North American species resemble it in the forms of the crown of the teeth, and it is probable, though uncertain, that they agree in other respects also. Several names have been proposed for our species, the earliest of which is *Macrosaurus* Owen. This name applies to species with compressed dorsal vertebræ, as *L. lævis* and *L. Mitchelli*, both from the New Jersey Greensand. For species with the depressed dorsal vertebræ, as *L. validus* from New Jersey, *L. perlatus* from New Jersey, and *L. proriger* from Kansas, the name *Nectoportheus* was proposed and briefly characterized."

The definition of *Tylosaurus* (*Rhinosaurus*) was explicit and exact, leaving no doubt of the genus to which it was intended to apply.

PLATECARPUS.

? *Holcodus* Gibbes, Smithsonian Contributions, ii, p. 9, 1850.
Platecarpus Cope, Boston Soc. Nat. Hist., 1869, p. 164.

Lestosaurus Marsh, Amer. Journ. Sci., June, 1872.

Medium sized Mosasaurs. Premaxillary short and obtuse, projecting very slightly beyond the teeth. Teeth slender, and recurved, faceted upon the outer side and striate on the inner. Nares much dilated anteriorly, situated forward. Frontal emarginated in the middle behind; pineal foramen large, situated near the frontal suture. Facial surface of parietal small, triangular in shape, the apex not extending beyond the middle of the bone. Prosplenial with a dilated wing-like process above. Quadrate large with a large suprastapedial process, reaching below the middle of the bone. Expanded portion of palatine short. Coronoid short and not prominent. Zygosphenes of vertebræ rudimentary. Cervical vertebræ seven in number. Thoracic vertebræ not more than fifteen in number, lumbo-dorsals nine or ten; pygial caudals five or six; chevrons large, articulated, spines of caudals regular in length, Limbs relatively large; arm and leg bones short and expanded; three or four carpal or tarsal bones present, closely articulating; pollex and hallux shorter than the fourth digit, divaricated. Coracoid with a deep emargination. Pelvic bones large; ischium much expanded distally; pubis without antero-proximal process.

The genus *Holcodus* Gibbes was proposed for the reception of a species supposed by him to be represented by three teeth from Alabama, South Carolina and New Jersey. Two of these were figured in his work cited (pl. iii, ff. 6-9), with the following description: "They are solid, and resemble in their pyramidal form those of *Mosasaurus hoffmani* antero-posteriorly, the dividing ridges making the anterior and posterior surfaces equal, and they are both convex. They are also acutely pointed. In *Mosasaurus* the outer surface is plane or nearly so, and both have longitudinal narrow planes near the base. * * In the teeth under notice, on the outer half are many planes, almost grooves, and also on the inner face, which is peculiarly striated toward the base. As the striated character is a structural distinction, the name *Hólcodus* is given to the genus, and that of *acutidens* to the species." Professor Leidy afterward* showed that only those teeth from Alabama belonged to a Mosasauroid, the ones from New Jersey being those of a crocodile (*Hyposaurus*). He describes Gibbes' type as follows: (op. cit.) "The specimen has the enameled crown three-fourths of an inch in length. The base is elliptical in transverse section, and measures five lines antero-posteriorly, and four lines transversely The crown is nearly equally divided by acute ridges, which are im-

*Cret. Reptiles of the United States, p. 32, foot note.

perfect in the specimen, but appear not to have been denticulated. The surfaces are subdivided into narrow, slightly depressed planes, and the inner one is strongly striate at the base." He is inclined to refer the tooth to *Mosasaurus*, a view in which Marsh coincides after examination of the type.*

I cannot agree with these authors. Whatever the tooth may be it is not that of a Mosasaurus. Professor Cope erected the genus *Platecarpus* for a species which Leidy had previously referred to *Holcodus*, under the name *tympaniticus*. The specimen which he described was from Mississippi. Later Cope applied the name *Holcodus* to two species from Kansas (*H. coryphæus and H. ictericus*), but which he later placed in *Platecarpus* after the name *Lestosaurus* had been given to the genus represented by them. Cope in his Cretaceous Vertebrata (p. 141) says: "The teeth of the Kansas species referred to it are somewhat similar in character to those described by Gibbes; but it is evident that the latter belonged to a different animal more nearly allied to the true *Mosasaurus*." Of *Platecarpus tympaniticus* very little of the skeleton has been described, and the tail is not yet known. At one time, Cope stated that the tail vertebræ of *Platecarpus* had co-ossified chevrons, upon what authority I can not learn. Marsh based the distinction of *Lestosaurus* largely upon that character, apparently following Cope. The quadrate of *P. tympaniticus*, as figured by Cope certainly looks very much like that bone of the Kansas species, and the quadrate in this genus is a very characteristic bone. These questions then, are to be settled before the name *Platecarpus* can be finally accepted for the Kansas forms: First, Is the typical *Platecarpus* identical with *Holcodus?* I believe that it is. The teeth of the Kansas forms agree perfectly with Leidy's description and figure of the type specimen of *Holcodus*. Second, Is *Platecarpus tympaniticus* congeneric with the Kansas species placed in this genus. This also appears to be true, but it is by no means yet proven. If both propositions are true, our species must be known as *Holcodus*. If the latter only is true, *Platecarpus* will be retained; while if the former is alone true, the name *Lestosaurus* will take precedence. It is a pity that little or nothing has been added to our knowledge of the southern and eastern species of this group within the last twenty years. Perhaps we may expect more definite knowledge concerning them in the immediate future. There is no inherent improbability that the Alabama or Mississippi species are not congeneric with the western ones, inasmuch as we know positively that one genus at least, *Clidastes*, does occur in all these regions, and it does not seem at all unlikely that all of them are common to the different horizons.

*Amer. Journ. Sci., June, 1872.

Some New Cirriped Crustaceans From the Niobrara Cretaceous of Kansas.

BY W. N. LOGAN.

Hitherto but very little has been made known concerning the Crustacea of the American Cretaceous. In the following communication are given the descriptions of several forms of Cirripeds, specimens of which have been collected during the past year or two in the western part of Kansas. Their horizon is from the lower-most part of the Ornithostoma Beds, and from the Yellow Chalk. Figures and further descriptions will be given in Vol. I, of the Paleontology of the University Geological Survey, now in preparation.

Squama Gen. Nov.

Capitulum composed of from nine to twelve plates of medium size and sub-triangular; peduncle short, composed of seven rows of plates, tapering gradually, to near the extremity, and ending in a rapidly, almost abruptly diminishing reflex area of smaller plates; form adhering to Inoceramus by its entire length.

Squama spissa n. sp.

Capitulum composed of twelve plates, viz.; carina, terga, (2), scuta (2), rostrum, subrostrum, subcarina, superior laterals (2), and carino-laterals (2). Height of capitulum from base to tip 19 mm.; width (lateral) from carina to subrostrum 17 mm. Carina long, narrow, somewhat shield shaped, and slightly convex; length 5 mm.; maximum breadth 2 mm., overlapping lateral in one specimen. Torga, triangular, with apex pointing toward base of capitulum, and base somewhat rounded; very slightly convex smooth; length 10 mm.; breadth (maximum) 15 mm., joined closely with laterals in one specimen. Scuta large, convex, in general shape triangular; superior border almost straight; rostral border convex, base smooth, slightly concave, length (10) mm.; maximum breadth 7 mm., adhering closely to superior lateral and overlapped by rostrum. Rostrum clubshaped, slightly convex; length 6 mm.,

breadth 2 mm. Subrostrum with the same characteristics as rostrum, except that it is smaller. Carino-laterals long, triangular, with apex distal, smooth, length 10 mm. Maximum breadth 4 mm. Superior laterals shorter 3 mm.; otherwise much the same as carino lateral. Peduncle short, composed of seven rows of plates; plates oblong, narrow, overlapping, short; maximum breadth 6 mm.

The type specimen was collected from the base of the Ornithostoma Beds by the writer, in Jewell county.

Squama lata, n. sp.

Capitulum composed of ten plates, viz.; carina, targa (2), scuta (2), subcarina, superior laterals (2), carino-laterals (2): height 8 mm.; width 16 mm. Carina long, narrow, rounded, slightly convex, the surface marked by parallel striæ; height 4 mm., breadth 2 mm. Terge triangular, with the base rounded; slightly convex, the surface smooth; length 8 mm., maximum breadth 4 mm. Scuta large, convex, quadrangular, its superior lateral border somewhat rounded; rostral border straight, surface marked; length 8 mm., breadth 5 mm. Carino-laterals long, triangular, the surface marked by transverse lines; length 8 mm., breadth 3 mm. Superior laterals shorter, resembling the carino-laterals in general shape. Peduncle short, its maximum breadth 6 mm.; composed of seven rows of plates; plates quadrangular, with the upper border curved; six or seven larger plates in the upper part of a row, succeeded below by about ten very much smaller ones.

Type specimen adhering to Inoceramus shell by its entire length. The type specimen was presented by Mr. M. R. Watson, of Trego county, and had evidently come from the lowermost beds of the upper Niobrara.

Stramentum, Gen. Nov.

Capitulum composed of eight or nine plates; plates of the peduncle narrow, with the ends turned down, presenting a thatched appearance; plates each with a groove running longitudinally. The two known species of this genus are evidently from a higher horizon than those previously described, coming from the yellow chalk, or the same beds that contain the toothed birds.

Stramentum Haworthi.

Pollicipes Haworthi Williston. University Geol. Surv., Vol. II, p. 243, pl. XXXVI.

Capitulum small, composed of nine plates, viz.; carina, scuta (2) terga (2), latralia (4): height 10 mm., breadth 8 mm. Terga triangular, with the apex pointing toward the base of the capitulum;

surface marked by striations, moderately indented in the type specimen; height 10 mm.; greatest breadth 4 mm. Superior laterals triangular, with the apex rounded; convex overlapping scuta in the single specimen; height 9 mm., breadth at base 13 mm. Scuta shorter than the superior laterals, their edges slightly rounded; moderately convex; triangular with the apex truncated; height 8 mm., breadth at base 3 mm. Carino-lateral in position, its general shape triangular, with the apex truncated by a line parallel with the base, which is inclined at an angle of thirty degrees towards the base of the capitulum; height 10 mm.; breadth at base 2 mm. Carina long, narrow, rounded; height 10 mm.; breadth at base, 2 mm. Peduncle composed of nine rows of plates; plates narrow, 1 mm. in breadth and 4 mm. in length, with about thirty plates in each row; plates turned downward at end, grooved along central line. Height of specimen 27 mm.; height of capitulum 10 mm. Weight of peduncle 17 mm.

The type specimen attached to an *ostrea congesta* by the extremity of its peduncle. It was discovered by Professor Haworth and placed provisionally in the genus Pollicipes by Professor Williston in the work cited. Its horizon is the Yellow Chalk from the vicinity of Gove City in Gove county.

Stramentum tabulatum, n. sp.

Capitulum composed of eight plates, viz.; terga (2), scuta (2), lateralia (4); height 5 mm., breadth 7 mm. The plates are flat and marked by lines and the whole capitulum is short and pointed. Terga triangular, the longest side of the triangle adjoining the carino-lateral, the shortest side adjacent to the superior lateral; breadth at base 2 mm., height 5 mm. Scuta small, but one half the size of the terga; triangular, almost equilateral. Carino-lateral long, moderately narrow, triangular, the most acute angle at the apex, height and breadth about the same as those of the targa. Superior laterals small, in the form of an isosceles triangle and of about the size of the scuta. Peduncle short, rounded, composed of six, or possibly seven rows of plates, with about sixteen plates in each row; plates less than 1 mm., in width, their length more than 2 mm.; turned downward at the ends and overlapping in rows. Type specimen collected by Mr. H. T. Martin from the Upper Niobrara Chalk of the Smoky Hill River.

Power of a Twelve Foot "Power" Windmill.

BY E. C. MURPHY.

In Vol. VI, No. 2, Series A, of the KANSAS UNIVERSITY QUARTERLY the writer gave the results of some windmill tests made during the summer of 1896 for the U. S. Geological Survey. The results of one of these tests, namely, that of a twelve foot power Aermotor we wish to discuss more fully, especially from a mathematical standpoint.

This mill is on a thirty foot steel tower. The wind wheel has eighteen curved fans, each $44 \times 18\frac{3}{4} \times 7\frac{3}{4}$ inches, set at an angle of 31° to the plane of wheel. The shaft is geared forward 6 to 1, so that the brake pulley makes six revolutions to one of wind wheel. The method of measuring the wind velocity and the power of the mill are fully described in the article referred to above, and need not be repeated here.

The curves CR, FS, and HT, Fig. 1, show the relation between wind velocity and horse power for brake loads of 2 lbs., 4 lbs. and 6 lbs. respectively on an arm of $35\frac{1}{4}$ inches. The curve AK is tangent to these curves and is the envelop of them.

MATHEMATICAL RELATIONS DERIVED FROM THESE LOAD CURVES.

Curve AK. This curve crosses the axis x, of wind velocity at about $x=5$, and is seen to resemble a parabola whose axis is vertical and coincides with that of axis y (horse power). We may assume for it the form

$$x^2=a+by \qquad (1)$$

in which a and b are constants whose values are to be determined. We see that for $x=5$, $y=0$ and for $x=15$, $y=.58$, hence $a=25$ and $b=345$ and equation (1) becomes

$$x^2=25+345y \qquad (2)$$

x being wind velocity in miles per hour.

If any other value of x, as 21, be substituted in (2) and the value of y computed it is seen to agree very closely with the ordinate of the curve.

It is seen that the curve AK is tangent to the 2 lb. curve at 9 to 10; to the 4 lb. curve at $x=15$, and to the 6 lb. curve at $x=20$ to

21, hence the envelop curve is tangent to the load curves for loads and velocities as follows—

Loads......	0	1	2	3	4	5	6
Velocities (x)	5	7½	10	12½	15	17½	20

that is, for each increase of velocity of about 2½ miles per hour, starting with 5 miles, there is an addition of one pound of load.

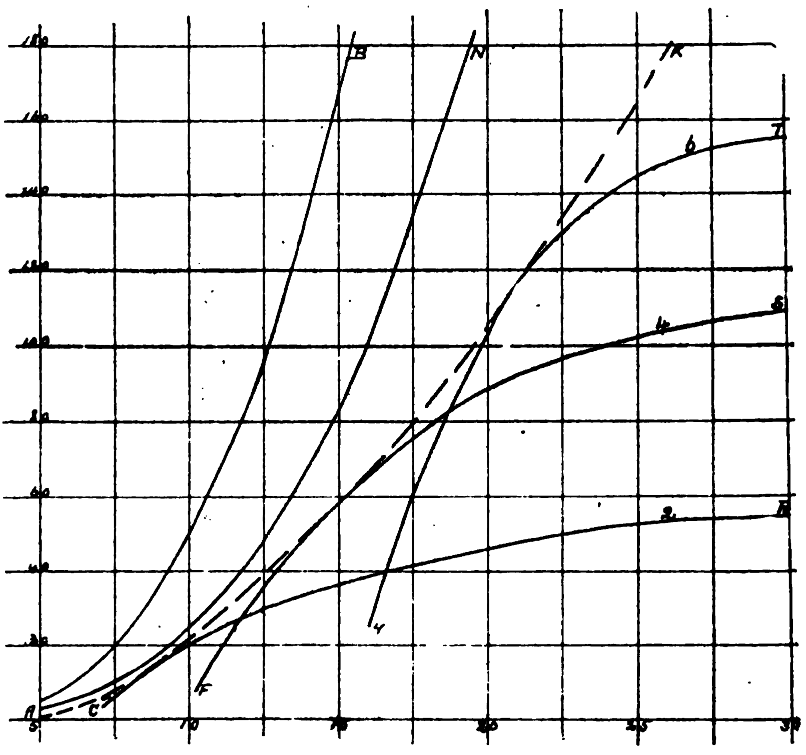


Fig. 1.

Hence for this curve AK the relation between load and wind velocity is,

$$\text{load } z = -2 + \tfrac{2}{5}x \qquad (3)$$

x being in miles per hour and z in pounds.

To find the relation between wind and velocity and velocity of wind wheel, v, for this curve we notice that y in (2) being, horse power is proportional to the product of the brake load and the velocity of the wind wheel or $y = kvz$, k being a constant. Substituting for y this value in (2) we have

$$x^2 = 25 + 345(k.v.z) \qquad (5)$$

Substituting for z its value from (3) in (5) and reducing we have

$$x^2 - 138kxv + 690kv - 25 = 0 \qquad (6)$$

Ideal curve AK.

The relation between load and wind velocity in (3) is for the useful load only. The mill also carries a useless friction load, to be considered further on. Now, if this useless load could be made to decrease as x decreases and become zero when x is zero, that is, the mill start in the lightest breeze then the curve AK would pass through the origin where x is zero and y is zero and be of the form

$$x^2 = b'y \qquad (7)$$

Most of this curve would differ little from the actual curve AK. Equation (3) would then be of the form

$$z = b''x \qquad (8)$$

and (6) of the form $x^2 = k'vx$ or $x = k'v$ (9)

that is, for the curve AK of the ideal mill the velocity of the wind wheel and also the useful load on the mill increases uniformly as the wind velocity increases. This curve shows the maximum power of the mill for any wind velocity, and in order for the mill to furnish it, it is necessary to increase the load on the mill at a rate equivalent to one pound on an arm of $35\frac{1}{4}$ inches, or an amount such as to yield 111 feet pounds per revolution. It will then be found that the velocity of any part of the wind wheel is increasing at a rate given by the equation $v = \frac{9}{10}Rx$ (10)

R being the distance in feet from the part to center of wheel, and v and x being in feet per second.

THE LOAD CURVES CR, FS AND HT.

These curves are seen to resemble parabolas whose axis is parallel to axis x. The equation of such a curve is of the general form

$$x = a + by^2 \qquad (11)$$

a and b are constants for either curve.

For the curve CR we have $y = .2$ when $x = 10$. and $y = 37$ when $x = 15$. Hence $a = 8$ and $y = 52$ approximately and (11) becomes

$$x = 8 + 52y^2 \qquad (12)$$

x being in miles per hour and y in horse power.

If this equation be plotted it will be seen that it coincides with CR very nearly to about $x = 20$, beyond this it is above CR, and the distance between them increases with x. The reason why CR falls below the parabola is due to the reduction of wind area or governing of the mill. The wind is constantly changing its direction and the wind wheel does not respond quickly to those changes of direction. It is pulled into the wind by a spring fastened to the tail, and the quickness of its response to changes of direction depends on the tension of this spring. The greater the wind velocity the

longer it is in coming full in the wind and the greater the reduction of effective wind area and consequent loss of power. If the wheel would stay full in the wind up to, say thirty miles per hour, the curve CR would probably coincide with the parabola up to this value.

The curves FS and HT are approximately parabolas, but the departure from the parabolic form increases as the load on the mill and wind velocity increases.

MATHEMATICAL RELATIONS BASED ON THEORY AND EXPERIMENT.

Sir Isaac Newton, in his "Principia," gave the first practical formula for finding the resistance of plates to the motion of a fluid against them. His general theoretical formula for the pressure when the plane of plate is at right angles to direction of motion of the fluid is

$$P = \gamma A \frac{c^2}{2g} \qquad (12)$$

P is the total pressure in pounds on the area, A the greatest area of plate, γ the heaviness of fluid (pounds per unit volume), c the wind velocity and g the acceleration of gravity.

This formula when modified to give air pressure takes the form

$$P_1 = \frac{0.0027.B.A.}{(1+.003665t)B_1} c^2 \qquad (14)$$

t is the temperature in centigrade degrees, B the reading of barometer at place of observation, B_1 the barometer reading at sea level and zero centigrade and c the velocity of the air in miles per hour.

This purely theoretical formula has been tested by quite a number of scientists and engineers and found to have a correct form, but to need a coefficient in order to give the measured pressure. The value of this coefficient, as found by these experimenters, varies in value from 1.3 to 1.8. One of the latest and best of these values is 1.44, derived from Prof. S. P. Langley's experiments.

Introducing this value in (14) we have the formula

$$P_2 = \frac{0.00389BA}{(1+.003665t)B_1} c^2 \qquad (15)$$

The wind velocity c is in miles per hour.

For $t=8^\circ$ Cent., $B=28.9$ ins., the standard conditions of the atmosphere when the test was made (15) reduces to

$$P_3 = 0.00364Ac^2 \qquad (16)$$

P_3 is in pounds per sq. ft., A in sq. ft. and c in miles per hour. If c is in ft. per second (16) takes the form

$$P_3 = 0.00169Ac^2 \qquad (17)$$

PRESSURE ON AN INCLINED PLATE.

Newton's formula for fluid pressure on a plate inclined at an angle β with the direction of motion of the fluid is

$$P_1 \quad \gamma A \sin^2\alpha \frac{c^2}{2g} \tag{18}$$

Measurements of this pressure on inclined plates show that this formula has not the correct form. Prof. S. P. Langley's experiments show that wind pressure on an inclined surface is normal to the surface, varies with the shape of surface and the direction of the longest edge, whether at right angles to direction of wind or parallel to it, and that the pressure is much larger than that given by Newton's formla. Fig. 2 shows curves given the relation be-

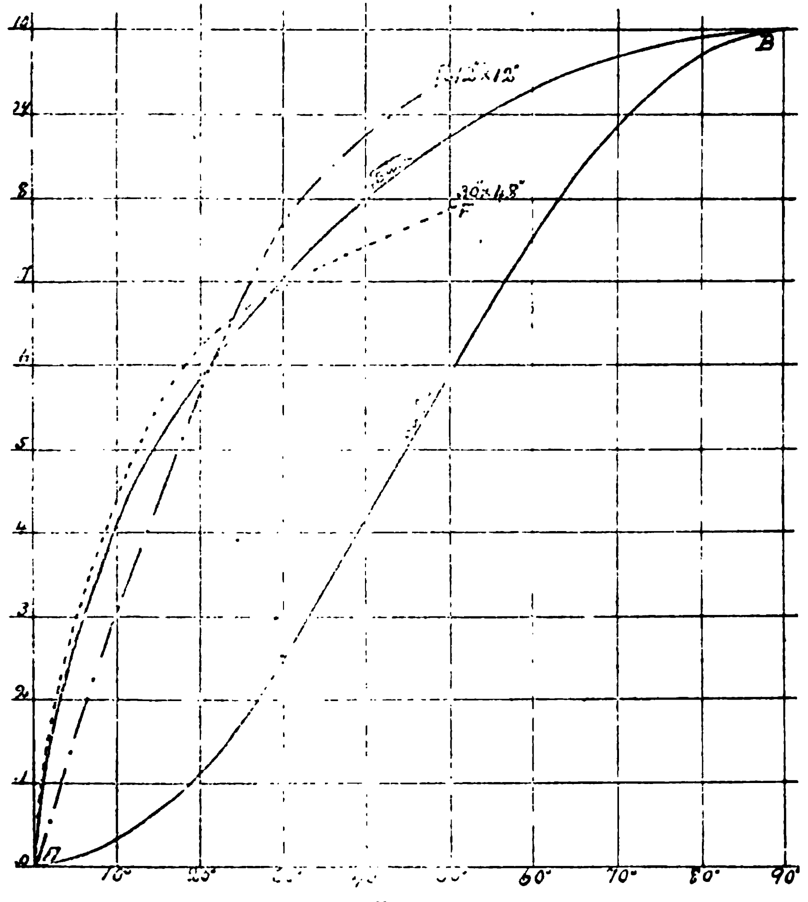


Fig. 2.

tween the ratio $\frac{P\alpha}{P_{90}}$ for value of α, $P\alpha$ being the normal pressure on a plane making an angle α with the direction of motion of the wind, P_{90} being the pressure when $\alpha=90^{\circ}$. The curve AE is one given by Prof. Langley for a 12x12 in. plane, AF another by Prof. Langley for a 30x4-8 in. plane (ratio 6.2) the longer edge being at right angles to direction of wind. The curves for $\sin^2\alpha$ and $\sqrt{\sin\alpha}$ are also shown.

The fans of our wind mill have a mean width of 13¼" and a length of 44 ins. The ratio of length to mean width is 3.1. The fans are slightly curved. We do not know the value of $\frac{P\alpha}{P_{90}}$ for the fans of this mill but these values lie somewhere between the values given by the curves AE and AF and they cannot differ much from those of $\sqrt{\sin\alpha}$.

It is easily seen from the curves $\sin^2\alpha$ and $\sqrt{\sin\alpha}$ that any formula for the power of a wind mill based on the assumption that the normal pressure varies as $\sin^2\alpha$ is very much in error. The formula then for the normal pressure on an inclined surface like the fan of a wind mill when not moving is from equation (18)

$$P_{s}=0.00169A\sqrt{\sin\alpha}c^{2}. \qquad (19)$$

P_s is lbs. per sq. ft., A is sq. ft. c in ft. per second.

PRESSURE ON MOVING FAN OF WIND MILL.

In the formula (19) the surface A is stationary and the wind is striking it with a velocity c. The fans of a wind mill are moving in a plane at right angles to the direction of the wind. Let v be the volocity of a strip of a fan at a distance R from the axis of wind wheel.

In Fig. 3*, AB is this strip making an angle β with the direction of the wind. Completing the parallelogram on v and c we have v_1 the relative velocity, or velocity of wind with respect to moving fan. v_1 makes an angle α with the direction of the wind.

The normal pressure on this strip would be that due to v_1 if the strip did not move away from the wind, but the strip being inclined to v_1 is moving away from it, and the velocity producing pressure is v_1 minus the amount that the surface moves away from v_1 in the direction of v_1.

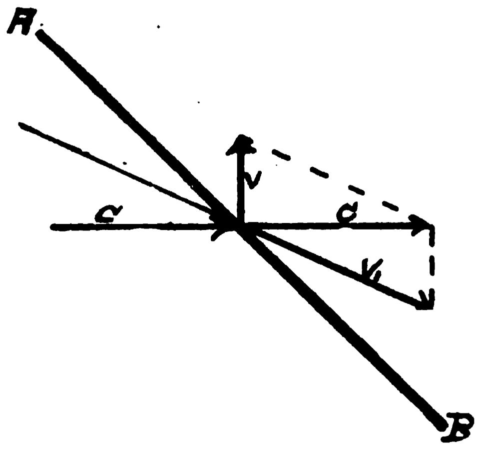


Fig. 3.

In Fig. 4, AB represents the position of the strip at the beginning of a second and A_1B_1 that at the end of the second. The wind at the beginning of second meets strip at A at the end of second it meets it at D, that is, while the strip has moved a distance

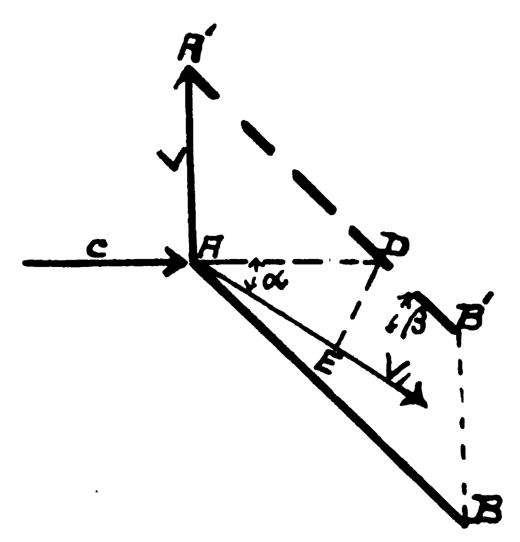


Fig. 4.

v it has moved in the direction of c a distance $AD = v\cot\beta$. While it has moved this distance in direction c it has moved AE in the direction of $v_1 = v\cot\beta\cos\alpha$. Hence the velocity producing pressure is

$$\bar{v}=v_1-v\cot\beta\cos\alpha=\sqrt{c^2+v^2}-v\cot\beta\cos\alpha \qquad (20)$$

Substituting this value for c and A^1 for A in (19) we have for the normal pressure on a moving strip of mill

$$P_n^1 = 0.00169A^1(\sqrt{c^2 - v^2} - v\cot\beta\cos\alpha^2)\sqrt{\sin\alpha} \qquad (21)$$

From Fig. 3 $\tan\alpha = \frac{v}{c}$ ∴ $\sin\alpha = \frac{v}{\sqrt{c^2 - v^2}}$ and $\cos\alpha = \frac{c}{\sqrt{c^2 - v^2}}$

Substituting these in (21) we have

$$P_n^1 = 0.00169A^1\frac{(c^2 - v^2 - cv\cot\beta)^2}{\sqrt{c^2 - v^2}}\frac{\sqrt{v}}{(c^2 - v^2)^{\frac{1}{4}}} \qquad (22)$$

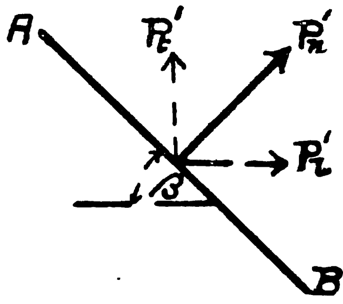


Fig. 5.

This normal pressure P_n^1 on a strip is shown in Fig. 5. Resolving it into two components, one in the plane of the wheel, the other at right angles to it, we have for P_t^1 the component which produces rotation $P_t^1 = P_n^1\cos\beta$. This tangential pressure multiplied by v and divided by 550 the number of ft. lbs. per sec. in a horse power.

$$(HP)^1 = \frac{0.00169A^1\cos\beta}{550}(c^2 - v^2 - cv\cot\beta)^2\frac{v^{\frac{3}{2}}}{(c^2 - v^2)^{\frac{5}{4}}} \qquad (23)$$

Equation (23) gives the horse power of a strip of one fan. To find the horse power of the mill we must divide a fan into such a number of strips that v may be considered the same for all points of it, apply (23) to each one of these, add these and multiply the result by the number of fans in the wheel.

Equation (23) contains three variables, horse power, wind velocity and velocity of strip. If any relation between v and c be known by substituting this in (23) the resulting equation is a relation between horse power and wind velocity. This general equation then includes all the equations that can be gottten by varying the load on the mill. The two lb. curve, CR, for example, since the load is constant for it, is the relation between v and c, as well as the horse power for the useful load. By substituting this rela-

tion in (23) we get the relation between total horse power (useful and useless) and wind velocity for one strip. The relation between v and c for the curve AK is given in equation (10) namely $v = .2Rc$. Substituting this value in (23) we have

$$(HP^1)_1 = \frac{0.00169A^1\cos\beta}{550}\,\frac{(1+(.2R)^2+.2R\cot\beta)^2}{[1+(.2R)^2]^{\frac{5}{4}}}(.2R)^{\frac{3}{2}}c^3 \qquad (24)$$

Fig. 6 shows one fan of this mill divided into four strips. The

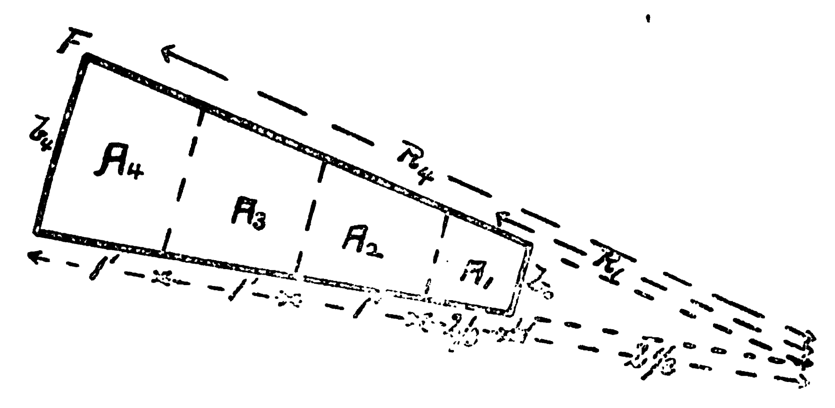


Fig. 6.

values of b, R, v, A and α for each strip are given in table I. Since $\tan\alpha = \frac{v}{c}$ and $v = .2Rc$, $\tan\alpha = .2R$, that is α is constant for any strip for all values of c.

For one of the constant load curves as CR, $v = \sqrt{\frac{c-a}{b}}$, see equation (11) $\therefore \tan\alpha = \frac{\sqrt{\frac{c-a}{b}}}{c} = \sqrt{\frac{c-a}{bc^2}}$, hence α must decrease as c increases.

From (21) it is seen that as α decreases P_n decreases, and consequently the power of the mill.

TABLE I.

b	R	v	A	α^0
.647				
.801	2.7	.53c	.483	47°—30′
1.062	3.5	.7c	.922	41 —45
1.312	4.5	.9c	1.177	34 —47
1.563	5.5	1.1c	1.441	27 —53

Substituting for A^1 and R the different values shown in table I and for $\cos\beta$ its value, and multiplying by 18, the number of fans, we have for the total horse power of this 12 foot mill

$$(\text{H.P.})=\frac{0.00169\text{x}.515}{550}(1.481+.773+.376+.128)c^3$$
$$=.0000787c^3 \qquad (25)$$

c being in feet per second.

Equation (25) is a cubical parabola and is the curve AN shown in Fig. 1.

TOTAL POWER OF WIND.

The total energy of the wind which strikes the fans of this mill is kinetic energy, $KE=\frac{1}{2}Mc^2$, M being the mass of air striking the fans per second and c the wind velocity in feet per second. M=volume multiplied by heaviness and divided by acceleration of gravity, and volume=area A multiplied by c, hence we have

$$KE=\frac{\gamma A c^3}{2g} \qquad (26)$$

Dividing (26) by 550 to reduce to horse power we have

$$(\text{H.P.})=\frac{\gamma A c^2}{2g550} \qquad (27)$$

Substituting for γ, A and g their values for the atmospheric conditions we have $(\text{H.P.})=.000156c^3$ (28)

Equation (28) is a cubical parabola. It differs from (25) only in the value of the coefficient, which is about twice that of (25). This equation is represented by the curve AB, Fig. 1.

It appears then from (25) and (28) that this mill when loaded with a uniformly increasing useful load is using at all wind velocities about half the energy of the air which strikes its fans. From (25) and (2) it appears that the total power that this mill takes from the wind varies as the cube of the wind velocity, but that the useful power yielded varies only as the square of the velocity.

On New Canonical Forms of the Binary Quintic and Sextic.

BY BESSIE E. GROWE.

INTRODUCTORY NOTE.

The reduction of the non-singular binary cubic and quartic by linear transformation to their canonical forms $(a,0,0,d)(xy)^3$ and $(a,0,d,0,e)(xy)^4$, was achieved by Cayley early in the development of the Invariant theory. In the year 1882, Brill (Math. Annalen, XX., p. 330,) and Stephanos, in the "Mémoire sur les faisceaux de formes binaires ayant une même Jacobienne," (Tome XXVII, of the *Savants Étrangers* of the Académie des Sciences, 1883) showed that the sextic was reducible by linear transformation to the form $(a,0,c,d,e.0,g)(xy)^6$. In Elliott's Algebra of Quantics, 1895, Chap. XIII, is to be found a discussion of Hammond's canonical form of the quintic $(a,b,0,0,e,f)(xy)^5$. (See last paragraph of the preface).

In a paper on Hessians and Steinerians of Higher Orders in the Geometry of One Dimension, published in the Annals of Mathematics, Vol. XI, page 121, I gave the following theorem: *Every non-singular quantic of odd degree may be linearly transformed so that its two middle terms shall vanish; this may be done in* $\left(\frac{n-1}{2}\right)^2$ *distinct ways.* I was in possession of this result at least a year before the appearance of Elliott's book.

Miss Growe undertook, at my suggestion, to find the two new canonical forms of the quintic and sextic, which theory showed must necessarily exist.

There is still lacking a general theory of these canonical forms for higher quantics. Such a theory must involve the notion of Jacobians and Cremonians of higher orders in some way analogous to my theory of Hessians and Steinerians of higher orders.

H. B. NEWSON.

A binary *n*ic may be interpreted geometrically as a system of points on a line. When the *n*ic is written in full, the ground points (see Clebsch, Algebräische Formen, Chap. II,) are in no special way related to the points of the *n*ic; but, in order to simplify the form of the *n*ic, we may, without any loss of generality, choose any two points on the line as ground points.

Since changing the ground points is equivalent to a linear transformation, canonical forms of the *n*ic may be obtained by choosing the ground points of the system of binary coordinates on certain covariants of the *n*ic.

I PROBLEM: To find the covariant C upon which to take the ground points in order to reduce the quintic $(a,b,c,d,e,f)(xy)^5$, to the form where b and e are zero.

$xy=0$ is the equation of the ground points.

If the ground points are to be on C, then x and y must divide out, or the coefficients of the first and last terms of C are zero. The problem then becomes:

To find the covariant C, the coefficient of whose first (and necessarily last) term is zero, when b and e are made zero.

(a) is the first coefficient of the quintic (a);

$(ac-b^2)$ is the first coefficient of the Hession (H);

$(ae-4bd+3c^2)$ is the first coefficient of a quadratic covariant (I);

$$a^2(ae-4bd+3c^2)-3(a^2c^2-2ab^2c+b^4)=0$$

when b and e are zero.

$\therefore$ the first (and last) term of the 12ic $(a^2\text{I}-3\text{H}^2)$ disappears when b and e are zero.

$$\therefore\ C=(a^2\text{I}-3\text{H}^2).$$

This covariant is of order 4 in the coefficients, and 12 in the variables. Since theory shows that the points of this covariant are associated in pairs, we have six different pairs of points which may be chosen as ground points.

Thus we have six different pairs of linear factors of the covariant C which may be used to transform the quintic to this canonical form. Hence we have

Theorem 1: *A non-singular binary quintic may be brought by linear transformation to the canonical form* $(ax^5+10cx^3y^2+10dx^2y^3+fy^5)$ *in six different ways.*

It may be interesting to know that C, in turn, is found to be the Jacobian of the quintic and another covariant S, whose second term disappears when b and e are zero, and is of the ninth degree.

Using Bruno's tables:

$$S = I_4\ \phi_{3.9} + 3(\phi_{3.3}\ \phi_{4.6} + \phi_{2.2}\ \phi_{5.7}) - \phi_{3.5}\ \phi_{4.4} + \phi_{2.6}\ \phi_{5.8}.$$

II PROBLEM: To find the covariant C_1 upon which to take the ground points in order to reduce the sextic $(a,b,c,d,e,f,g)(xy)^6$ to the form where b and f are zero.

$(a^2d-3abc+2b^3)$ is the first coefficient of the Jacobian (J).

$(ac-b^2)$ is the first coefficient of the Hessian (H).

(a) is the first coefficient of the sextic (a).

$(a^2f-5abe+2acd-6bc^2+8b^2d)$ is an octavic covariant (L).

$$2(a^2d-3abc+2b^3)(ac-b^2)-a^2(a^2f-5abe+2acd-6bc^2+8b^2d)=0$$

when b and f are zero.

$\therefore$ the first and last term of $(2\mathrm{HJ}-a^2\mathrm{L})$ disappears when b and f are zero.

$$\therefore C=(2\mathrm{HJ}-a^2\mathrm{L}).$$

This is the form of Brill and Stephanos.

This covariant is of order 5 in the coefficients and 20 in the variables.

Theorem 2: *A non-singular sextic may be brought by linear transformation to the canonical form* $(a,0,c,d,e,0,g)(xy)^6$ *in ten different ways.*

This 20th degree covariant is further found to be the Jacobian of the sextic (a) and a covariant S_1 of the 16th degree, whose second term disappears when b and f are zero.

(a) is the first coefficient of the sextic (a).

$(ae-4bd+3c^2)$ is the first coefficient of a quartic covariant (K).

$(ac-b^2)$ is the first coefficient of the Hessian (H).

Forming the combination $(2a^2\mathrm{K}-\mathrm{H}^2)$:

$$2a^2(ae-4bd+3c^2)-(a^2c^2-2ab^2c+b^4)=$$
$$2a^3e-8a^2bd+5a^2c^2+2ab^2c-b^4$$

Using the operator D,

$$\left(g\frac{d}{df}+2f\frac{d}{de}+3e\frac{d}{dd}+4d\frac{d}{dc}+5c\frac{d}{db}+6b\frac{d}{da}\right)$$

To obtain the second coefficient, we have:

$$(4a^3f-24a^2be+40a^2cd+8ab^2d-40a^2cd$$
$$+20abc^2-20b^3c+6b(-\ -\ -\ -\ -\ -)=0$$

when b and f are zero.

$$\therefore S_1=(2a^2\mathrm{K}-\mathrm{H})^2.$$

III PROBLEM: To find the covariant C_2 upon which to take the ground points in order to obtain the canonical form of the sextic in which c and e are zero.

The following are first coefficients of covariants of the sextic in which c and e are made zero.

$a = C_{1.6}$ the sextic
$ag - 6bf - 10d^2 = I_2$
$-4bd = C_{2.4}$
$-b^2 = C_{2.8}$
$-b^2g - 3adf = C_{3.2}$
$-ad^2 = C_{3.6}$
$a^2d + 3b^3 = C_{3.12}$
$16abd^2 - 2ab^2f = C_{4.10}$
(Notated according to E. B. Elliott in *Algebra of Quantics.*)

Forming the covariant C_2, the coefficient of whose first term vanishes when c and e are zero, we have:

$$C_2 = 12C_{3.12}\, C_{4.10} - 48C^2_{1.6}\, C_{2.4}\, C_{3.6} - 8C^2_{1.6}\, C_{2.8}\, C_{3.2}$$
$$-8C_{1.6}\, C^2_{2.8}\, I_2 - 29C^2_{2.4}\, C_{2.8}\, C_{1.6}.$$

This covariant is of order 7 in the coefficients and 22 in the variables.

Theorem 3: *The non-singular sextic may be brought by linear transformation to the canonical form* $(a,b,0,d,0,f,g)(xy)^6$ *in eleven different ways.*

The covariant upon which the ground points are taken in order to drop the second, and next to the last terms of the—

cubic is of order 2 in coefficients, degree 2 in variables;
quartic is of order 3 in coefficients, degree 6 in variables;
quintic is of order 4 in coefficients, degree 12 in variables;
sextic is of order 5 in coefficients, degree 20 in variables;
$n$ic is of order $(n-1)$ in coefficients, degree $(n-1)(n-2)$ in variables.

From the consideration of the above relation between the order and degree of the covariant and that of the quantic itself, we may conclude that, in all probability the order of the covariant is given in general by $(n-1)$ and the degree by $(n-1)(n-2)$, where n is the degree of the quantic whose canonical form is required.

On the Action of Sulphuric Acid upon Strychnine, in the Separation of this Alkaloid from Organic Matter.

BY E. H. S. BAILEY AND WM. LANGE.

In the separation of the alkaloids from organic matter in the ordinary toxicological examinations, it has been found convenient to purify the alkaloid from the last portions of organic matter by evaporation of the partially purified material with a drop or two of strong sulphuric acid, and the question has arisen, to what extent does this operation destroy the alkaloid. The concentrated acid destroys the organic matter, and it would be strange if it did not, under these conditions, partially destroy the alkaloid or by hydrolysis or in some other way so change it that its presence could not be discovered by ordinary reagents. The object of these investigations was to determine if possible, to what extent this process affected the delicacy of the tests for the detection of strychnine.

The method employed for separation of an alkaloid from organic matter is usually that of Stas', modified by later investigators as the conditions of the case may suggest. For the separation of strychnine, the best method has been found to be to acidulate with acetic acid, and digest at a moderate temperature with diluted alcohol. This alcoholic solution is then evaporated and an aqueous solution is obtained, which is made alkaline with caustic potash and shaken with chloroform several times; the chloroform solution is separated, and evaporated to dryness, and the residue, dissolved in a drop of dilute acetic acid, is tested for strychnine by the appropriate reagents. If this residue is still impure, it will become colored when the sulphuric acid is added to it, on account of the decomposition of organic matter, for pure strychnine salts and sulphuric acid give no coloration, or only the very faintest trace of color.

The color tests for strychnine are considered very satisfactory if carefully performed, and in connection with the precipitation by alkaloid reagents and the examination of the crystals by the micro-

scope, and with the physiological test also, they can be depended upon to identify the alkaloid. Our experience has been that the most delicate tests could be made by the use of sulphuric acid and potassium bichromate. In this case the succession of colors, blue, purple and red is very characteristic. The color with some other oxidizing agent, as manganese dioxide, is frequently of value as a confirmatory test, especially in the presence of other substances such as caffein. With this latter reagant the color reactions appear more slowly, but are just as definite finally.

In these experiments the delicacy of the color reaction with sulphuric acid and potassium bichromate was first established. In order to do this, solutions of strychnine of various strengths were prepared by dissolving a known weight of the alkaloid in acetic acid and water. The strength of these solutions varied from one grain of strychnine dissolved in 1000 cc. of water to one part in 1,000,000. One tenth of a cubic centimeter of the solution, corresponding to one-tenth the weight of strychnine in one cubic centimeter, was evaporated to dryness on a porcelain crucible cover, over a water bath, taking care to have all the strychnine deposited at one point on the cover. This residue was then moistened with one drop of concentrated sulphuric acid and a minute particle of potassium dichromate was drawn through the droplet with a fine glass rod. This gave the characteristic color reaction. Beginning with a concentrated solution of strychnine, the tests were made in solutions of greater dilution till a point was reached at which it was not possible to detect the alkaloid by this test. The microscope was not used in the examination of the color test.

In the second series of tests, after evaporating the solution to dryness on the porcelain cover, it was treated with a drop of concentrated sulphuric acid, and heated for fifteen minutes on the water bath, then the test was made in the usual manner.

In the third series of tests the conditions were such as would prevail in the ordinary course of analysis, when organic matter is present. To each portion, before testing, a measured quantity of extract of beef was added, twenty-five cc. of alcohol and a few drops of acetic acid and the whole was digested for an hour on a water bath. The mixture was then diluted, filtered, and evaporated to dryness on a water bath, allowed to cool and dissolved in water acidulated with a drop of acetic acid. The solution was made alkaline with potassium hydrate and shaken out twice with chloroform, about ten cc. of this solvent being used each time. The mixed chloroform solutions were then evaporated to dryness

at 100° and the residue was moistened with a drop of sulphuric acid. This was warmed for fifteen minutes, then dissolved in water made alkaline with potassium hydrate and shaken out three times with chloroform. The mixed chloroform solutions were evaporated to dryness on a water bath, concentrating the residue to a small point on the porcelain surface, and the test was applied as in the preceding cases.

The results of these tests were as follows:

DELICACY OF THE CHEMICAL TESTS.

Fractions of a milligram present in the solution (x = limit, t = test).

	0.1	0.05	0.033	0.025	0.020	0.016	0.011	0.005	0.003	0.0025	0.0020	0.0016	0.0014	0.00125	0.0011	0.001	0.0005	0.00033	0.00025	0.00020
Series I. Tests with the plain solution:	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	x
Series II. Tests with strychnine and sulphuric acid.	t	t	t	t	t	t	t	t	t	t	t	t	t	t	t	x				
Series III. Tests with strychnine, sulphuric acid and organic matter.	t	t	t	t	t	x														

These experiments show that, though great care was exercised in the treatment of the residue, the action of the sulphuric acid decreases the delicacy of the reaction, so that although 25-100,000 of a milligram was detected in the original solution, after heating with sulphuric acid only 11-10,000 of a milligram was detected. After the treatment with sulphuric acid and the shaking out with chloroform, it was not possible to find the strychnine except in a solution that contained 2-100 of a milligram. It is evident that the treatment with sulphuric acid does diminish the delicacy, but that is not so large a diminution probably as the process of shaking out with chloroform. Although chloroform is an excellent solvent for strychnine, one part being soluble in eight parts of this menstruum, still so much of the strychnine is still retained in the organic matter that the portion that can be obtained from the chloroform solution is only a fraction of that which was originally present. It is probable that by more perfect extraction with chloroform, a greater quantity of strychnine can be obtained, but the experiments described above are made especially to show what will be the result, if the ordinary methods of extraction are followed.

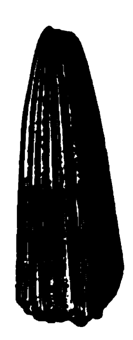
A New Labyrinthodont from the Kansas Carboniferous.

- -

BY S. W. WILLISTON.

With Plate XXI.

The past summer Mr. Herbert Bailey, of the University of Kansas, discovered, in the vicinity of Louisville in this state, a large fossil tooth in most excellent preservation. An examination of the tooth proved it to be of such especial interest that I shortly afterward visited the precise locality where it had been found, at the crossing of the Vermillion, east of Louisville, in company with Mr. Bailey. The geological horizon was determined by the discovery of other bone fragments, in situ. It is a dark grey shale. Below the bridge at the crossing there is an outcrop of about twenty feet of these shales, but no massive limestone layers, so that, without further examination, the precise position of the beds can not be determined. They are, however, nearly at the upper part of the Carboniferous, probably within one hundred feet of the Manhattan Limestone.



Labyrinthodont Tooth—natural size.

The specimen preserved comprises the entire crown, measuring thirty-eight millimeters in length by fourteen in diameter at the base. The immediate tip has been partly worn away in life, but was acuminate. It is composed of a dense blackish material, with the exterior smooth, shining black. It has about twenty narrow flutings nearly straight, running from the base to the tip, separating shallow grooves. A transverse section of the base shows a narrow pulp-cavity not more than five millimeters in diameter, which extends in about the same proportional width to beyond the middle of the tooth, and in all probability to near the apex. The cross-section of the tooth throughout is nearly or quite circular.

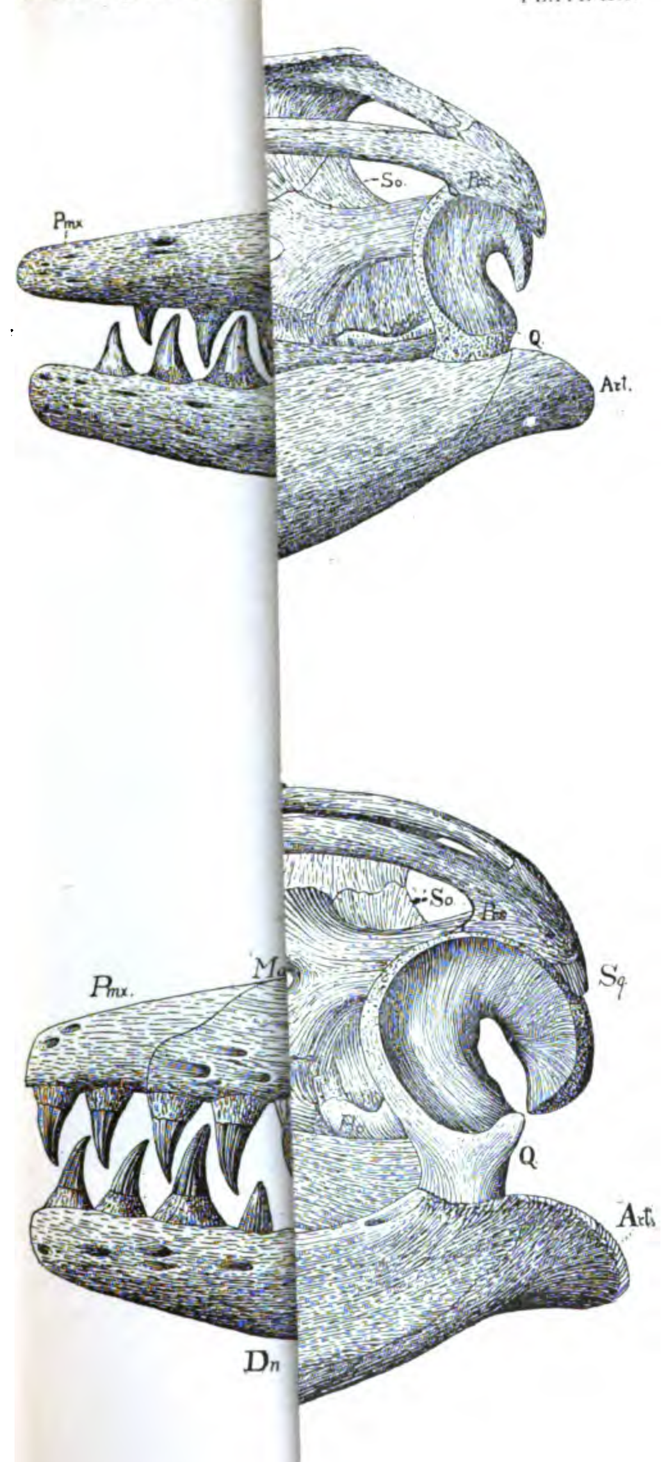
A hemisection of the tooth was made near the middle showed a structure most remarkably like that of *Mastodonsaurus*. So nearly alike, in fact, that I can discover no difference from the large figure

given by Owen of a section of *Mastodonsaurus*. Indeed, had the tooth been found in Triassic deposits, without other evidence, it would be referred to that genus. Whether or not important structural differences in the labyrinthodonts are accompanied by differences in the microscopic tooth-structure I cannot say, but, until such is shown not to be the case, the present tooth may be referred to the genus *Mastodonsaurus*.

From the difficulty of obtaining a sufficiently thin section of the very opaque material of which the tooth is composed, I have not been able to make a photograph showing the entire structure. Such, however, is unnecessary, as it will show but very little not already given by Owen for *Mastodonsaurus*. I give in an accompanying plate a half-tone reproduction of a photograph of a small portion of the tooth, showing under high magnification the minute structure of the dentinal tubules.

The discovery of this tooth in the Kansas Carboniferous is of great interest, proving, as it does, the presence of true labyrinthodonts from a lower horizon than I can find any record of elsewhere. It is the only labyrinthodont hitherto discovered in America, I believe, aside from some fragmentary remains from the Triassic, described by Cope. The footprints of Amphibians, described by Marsh from the Osage beds, show very clearly that such animals were both diverse and abundant in the Upper Carboniferous times of Kansas, and it is not at all improbable that some of those which Marsh described were made by animals with teeth like the one described, inasmuch as the geological horizons can not be far separated and may be identical.


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S. PRENTICE, del.



SECTION OF LABYRINTHODONT TOOTH.

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The Use of Analysis in Logical Composition.*

BY E. M. HOPKINS.

PRELIMINARY.

Need of logical analysis. In taking classes in advanced English composition through the subject of logical discourse, and especially argumentation,—the forensic and the debate,—the writer has had considerable difficulty in securing from students a satisfactory degree of clearness and of logical accuracy and order in the presentation of thought, whether in exposition or in argument, in mass or in outline. Text-books in logic do not ordinarily attempt to exhibit the logical structure of sections of discourse longer than a paragraph, while treatises on rhetoric either ignore entirely the structural theory of logical discourse, or discuss it on the synthetic side only, passing entirely over the matter of logical analysis; perhaps assuming that it belongs entirely to formal logic, and that so much of logical analysis as is taught in formal logic will fully answer the needs of those who desire to lay bare the structure of entire compositions, or to put together compositions that shall be correctly logical throughout.

All recent text-books in rhetoric give more attention to the theory of logical composition than was formerly done, but in practice there still seems to be something lacking. Usually directions are given for the proper ordering of exposition or argument, and for the making of outlines, accompanied with general explanations of the nature and applications of the more important forms of argument. But few, if any, show with precision how logical forms actually apply in practice. As a result of following their

methods in class work, it has often been found that because the principles stated are general the real nature of the process is not at all understood; that students' plans and briefs, apparently correct in form and beautiful to the eye, are often a logical tangle; and that forensics, though containing the best of material, often fail to present it so as to endure logical scrutiny.

It might of course be said that all popular reasoning is general reasoning; that it is usually sufficient for the purpose if a speaker or writer follows logical principles even approximately; that as the hearer or reader will rarely proceed to examine the structure of what is said for false steps or incorrect processes, there is no particular reason why one should waste effort in making sure that all his processes are absolutely exact; that it is enough if they are apparently right, and are accepted. The fallacy of these propositions is less likely to appear in expository writing; but in debate, and even in the forensic, when a skilled disputant proceeds to examine a structure apparently solid and finds a flaw in it, these propositions will probably afford little consolation to his victim. Occasions do arise when a lack of exactness in method may leave a writer helpless, and destroy entirely the value of his work.

Some inexactness is often found in the plans and briefs given in text-books as models: matters logically unrelated are massed together under a single head, matters logically related are placed remote from each other, and logical relations are not correctly indicated. And though an error in an outline may in the full discussion disappear, it is more likely to be magnified. It is thus suggested that the road to accuracy in presentation lies through an accurate outline of what is to be presented; accurate not alone in the number and arrangement of the heads, but accurate also in indicating their logical relations.

But if the simple statement of the general principles that should govern the construction of an outline proves insufficient, there is apparently no resource but to begin at the foundation; the foundation being the laws of formal logic, and the application of those laws in the logical analysis of entire compositions and of outlines of entire compositions, until the meaning of the laws and their practical value are fully understood.

General Method. Acting on this theory, the writer has endeavored to overcome the difficulties mentioned at the beginning, first by a brief review with a given class of the principles of formal logic, omitting everything that is merely formal and not practical, and then by studying the application of these principles in typical se-

lections, through an analysis which should not rest content with the construction of an outline, but which should subject the outline itself to the strictest possible logical examination. The process so carried on should give something more than the comprehension of the meaning of principles; it should also show how to construct an outline,—a plan or a brief,—so that the full logical significance of that for which the outline stands may be apparent to the eye. This is what all outlines are supposed to do, but they often fail to show relations even when they indicate quantity and quality reasonably well. One of the very first results of the use of this method has been to reveal imperfections and faulty or confused processes often in high places; but in such cases the causes are also revealed, and the general investigation is materially aided.

In following this method, another difficulty immediately presented itself as soon as argument was taken up. While the framework of an expository selection may be a reasonably simple thing, and so too in argument may be the chain of reasoning underlying a single paragraph, or the main outline of an entire discussion, the tabulating of the ultimate details which make up the support of the main outline is likely to result in a maze confusing equally to the eye and the intelligence, and so discouraging to a student that it may move him to decide that if there is no more royal road to logical accuracy than this, he will be content to reason haphazard for the rest of his life.

Use of diagram. To avoid this difficulty as far as possible, a system of illustration by diagram was evolved by instructor and students under pressure of necessity and a little at a time. By means of it, so far as tested, it has been found possible, using a simple classification of logical processes, to address the eye directly without the intervention of cumbrous verbal statements, and to represent an entire argument as by a map. Systems of this sort have often been devised, but little used; and whether this one is adequate to all forms of logical process is not yet demonstrated; or whether it may not be possible to simplify it greatly. Such as it is, it has sprung up in response to what seemed a pressing need; and as it may prove interesting if not helpful to others who may experience the same need, it is explained in this paper, and used in determining and expressing results.

General results obtained Through this system the results of a brief time spent with classes in the closest possible study of logical structure have been very satisfactory: a clearer comprehension of principles and processes, and a more perfect structure in creative work, from the outline to the completed

composition. The labor involved is very great, and is imposed upon a class as a requirement for a short time only; but it is noticed that those interested in logical processes, and especially in debate, continue to make use of the method. A detailed illustration of processes, and of results arrived at, follows.

EXPOSITION.

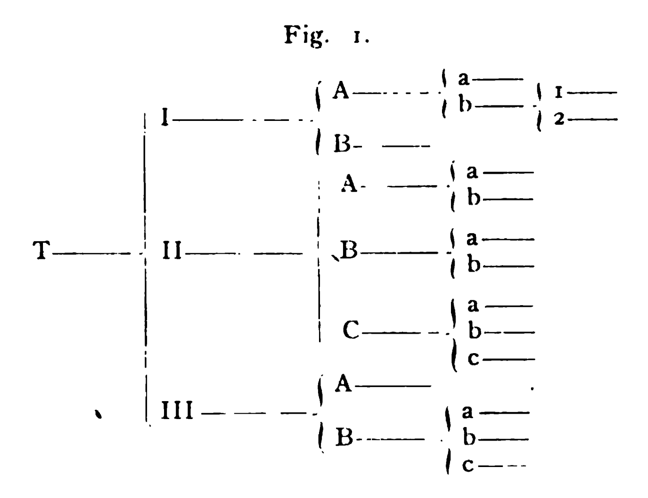
Processes involved. In approaching the study of any class of logical discourse, certain principles postulated by the nature of that class, may be laid down in advance. The logical principles or processes involved in exposition are, broadly speaking, those of limitation or definition, division or partition, enumeration or classification, subdivision or subpartition. If the object of exposition is to apply these processes, then the object of the outline of an exposition—technically called the plan, to distinguish it from the brief, the outline of an argument,--is to show how these processes are applied, and to make it evident that they are applied. It cannot therefore be constructed without analysis of what has been written or is to be written; and because it requires such analysis, it cannot be omitted without grave danger that the analysis will also be omitted, and the discussion be faulty.

Subject. What it requires in analysis. Given a subject for expository treatment, it is thereby implied that in analysis the subject shall be so phrased for treatment that it shall be definitely brought within limits not too great for the time or the occasion;or stated in another way, that the special phase of it which is of interest or importance enough to be discussed shall be definitely indicated. This phase is then to be resolved into its sub-phases, or its principal aspects determined; these are to be few, clearly distinguished from each other, as nearly as possible equal in value, and in sum fairly covering the ground indicated by the subject as phrased. Each sub-phase, or some of them, may then in turn be resolved into component elements which might be called sub-subphases. If this process is scientifically exact or as nearly so as may be, aiming in every stage at complete enumeration of parts, it is called division; if it is popular or less complete, aiming to enumerate only the parts that for some reason are of special interest, it may be called partition.* Whether it be division or partition, at its conclusion the results of the process may be represented to the eye by the following diagram:

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*See Cairns; Forms of Discourse, p. 190. (Ginn & Co., 1896.)

Fig. 1.



This represents perhaps an extreme case of division, since the process is not in ordinary articles or papers carried as far as is here indicated. T denotes the subject as limited, or the theme as it may be called. The parts resulting from the first division or partition are numbered I, II, and III. The parts resulting from the subdivision of these parts are conventionally lettered with capitals; parts resulting from the subdivision of these parts with lower case letters, and so on in the usual manner. If the process is one of division, it follows that I plus II plus III equals T; and that I, II, and III are of approximately equal importance. So A (III) and B (III) should equal III, and be nearly equal to each other, and so on throughout.

If the process is partition, that may mean that the parts of any group are less nearly equal, or that parts of any given group are entirely omitted because for some reason they are not important or significant. However, even in such a case as the latter, it should follow that the sum of the remaining parts is after all fairly or approximately equal to the thing divided, from the point of view from which the partition was made.

The plan: what the analysis requires in it. Such a diagram may indicate the logical form of a discussion, as revealed by analysis: but as the office of a plan is to do this, and also to show in brief the nature of the content of the discussion, and as in exposition the form of the discussion and the relations between its parts are always simple, the content being of chief importance, a plan answers every purpose in showing the results of analysis, and a diagram is unnecessary if the plan is properly made. From the analysis and the

diagram conclusions may be drawn as to the method of making the plan. Its form should indicate to the eye the form of the discussion and the relations of the parts of the discussion; and its headings should indicate to the mind what the discussion contains, or is to contain, as clearly, simply and fully as possible.

T in the plan, corresponding to T in the diagram, will therefore be, not a broad and indefinite term, but a term, phrase, or proposition so chosen or phrased or limited in application that the full content of it may be surveyed in the discussion to follow. The next step in the process is to make a partition or a division of the content of T. It follows that if there is division or partition, there can by no possibility be fewer than two resulting subdivisions; while if the principle of division is a significant one, as required by the law of logical division, the resulting subdivisions will not be many.

So when these parts are again divided, the number of sub-parts of each group should always be small, while in no case can it be less than two. It follows further that as the parts of a group, as for example A and B under I, bear to one another a likeness closer than that which exists between them and the parts of any other group, this likeness may appropriately be indicated by a corresponding likeness in the expressions which stand for them in the plan.

The plan when completed corresponds in form to the diagram, except that for convenience headings are placed on successive lines and the grouping is shown by indentations with or without a system of numerals such as that in the diagram. For example,—

T. Theme, phrasing limitation of subject to a special aspect.
- I. First sub-phase of T.
  - A.. First sub-phase of I.
    - a. Possible first part of A.
    - b. Possible second part of A.
  - B. Second sub-phase of I.
- II. Second sub-phase of T.
  - A. First part of II.
    - a. First part of II, A.
    - b. Second part of II, A.
    - c. Third part of II, A.
  - B. Second part of II.
- III. Possible third sub-phase of T, and so on.

Form of headings. Since the plan is to show content as well as form, the terms or expressions which stand as headings must be so well chosen and well phrased as to express the thought with full-

ness and with accuracy, yet without unnecessary verbiage. Each heading from the theme to the least subdivision should be definite, unambiguous, and complete in itself, indicating at a glance what is to be included in that part of the discussion. As each heading, except the ultimate ones, stands for a group that possesses a unity of its own, the heading should show in what that unity consists. A word or a phrase, if well chosen, may be sufficient; or a full proposition may be necessary. Ordinarily, however, the more strictly divisive the process, the briefer may be the headings. Finally, for a reason already stated, the headings of each group should as far as possible be parallel in form; phrase corresponding to phrase, participle to participle noun to noun, and so on: a rule not easy to follow in all cases, but deserving of attention.

It should be noted that a plan is not a synopsis. The plan does not show the actual content of the discussion, but the nature of that content; it is not a series of sample remarks selected from the discussion; but it is a series of statements or implied statements as to what the discussion is about. A synopsis on the other hand is sometimes made up of selected samples, but it should rather be a condensation; the discussion itself in brief. It is not necessarily a good synopsis, or a good plan, that is made up of expressions taken bodily from the discussion. The synopsis condenses; the plan analyzes; and each of them calls for special treatment not necessarily found in the discussion itself.

Systems of numerals. To indicate the form of the discussion either indentations or numerals or both may be employed. Numerals are necessary when there is not space for the open arrangement of headings with indentations, and in all cases when reference to parts of the plan is necessary. If such references are to be very numerous, it is often an advantage to number all the parts of any given order of subdivision consecutively, instead of beginning again at the beginning of every group; as in that case a single numeral serves to indicate the reference, while if the system just illustrated is used, several may be necessary. Figures with exponents or subscripts are sometimes used instead of letters in numbering headings. Two of these methods are here illustrated.

(Fig 2.)

T	T ....
I	1^1 ....
A	1^2 ....
a	1^3 ....
b	2^3 ....
B	2^2 ....
II	2^1 ....
C	1^2 ....
c	1^3 ....
d	2^3 ....
e	3^3 ....
D	2^2 ....

What is required in the amplification.

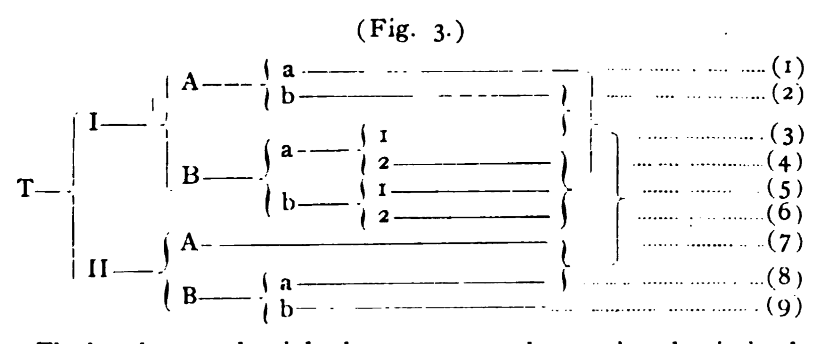
All the work thus far outlined is supposed to precede, and should precede, the formal discussion. If it does so, the actual discussion will become simply an amplification of the points indicated in the plan, in the order of the plan. If in process of amplification, new matters are suggested, or a change of order, the plan must be changed accordingly, so that the correspondence between plan and discussion may remain accurate.

At the head of the paper may stand some other title, or T phrased precisely as it is phrased in the plan. The latter is always advisable, although sometimes for special reasons a more general or less definite phrasing is used, or a title substituted bearing only a suggestive or figurative relation to the real theme. If the theme of the paper were: "The Advantages of a College Course to a Business Man," it might be possible to entitle the discussion "College Education," or "Over the Alps lies Italy,"; yet little is gained thereby unless it is concealment of the real theme, and a great deal may be lost.

The amplification itself is theoretically devoted to the definition and explanation of the various headings in their order, first T, then I, then I, A, and so on; definition dealing with the terms of each heading, and explanation possibly to the relations between them. In actual practice the meaning of the heading of a group afterward divided is often so clear that definition is unnecessary, and only its subdivisions need have a place in the amplification. It is also true that argument may be employed at almost any stage; that is, argument and exposition may be freely mingled in almost any discussion. In any case it is evident that with the completion of the plan the most important part of the work from the logical standpoint is already done. Questions of style may then be considered, but questions of logical process, except those involved in definition, are already settled.

Relation of plan to paragraphing. The paragraphing of the paper is, however, in a certain sense a logical process, and at least one general principle as regards its relation to the plan should be observed. The amount of matter to be contained in a paragraph is determined independently of the plan; a paragraph may correspond to a single head of the plan, or to several, according to the degree of minuteness to which the subdivision is carried. It may be longer or shorter according to its importance, the nature of its internal structure, the nature of its relation to other paragraphs, and even to some degree according to its appearance. But while it may contain the whole of any group of the plan, whether the group be of a higher or a lower order, or while it may contain two or more co-ordinate groups of any order, if those groups are united by a special relation, it may not contain the whole or a part of any one group and a part only of some other group. This is merely to say that the paragraph must satisfy the law of unity. Any paragraphing that gives a group to a paragraph, whether the group be large or small, is logically correct; but a paragraphing that brings together parts of different groups will not do. What this means is more clearly shown by a diagram.

(Fig. 3.)



The brackets at the right denote paragraph grouping that is inadmissible. Designating the ultimate parts of the indicated division by the figures at the right, we may say that each of those parts might possibly require a paragraph. If we proceed to group any of them together, with (1) may be placed (2), as their sum equals I, A, and is therefore still a unit. But if this paragraph is to be made still larger, (3), (4), (5), and (6) must all be added, the sum total then equalling I.

So (3) and (4) may constitute a paragraph, but (5) cannot be added without (6); and (3), (4), (5), and (6) together equal I, B. (5) and (6) may constitute a paragraph, but to that paragraph nothing can be added, unless it be from what has preceded.

In this diagram, it will be noted that headings representing groups afterward divided are not taken account of in the supposed paragraphing. This is for the reason that in a well constructed plan such headings, as noted on a preceding page, are often so clear as to require no definition or explanation in the amplification, and therefore have no place in the paragraphing apart from their subdivisions. When because of special definition or explanation they do require a place in amplification and paragraph, that place may be indicated as follows:

A. (Definition or explanation of A).
  a. First division of A.
  b. Second division of A.

or

A— { a. Definition { 1. First, 2. Second; b. Division }

and it becomes apparent that for purposes of paragraphing, the amplification of heading A is co-ordinate with that of its subdivisions a and b.

Application of principles stated. So much of theory is arrived at simply through the consideration of the logical character of exposition, the analysis thus far involved being the analysis of what is not yet written; the analysis of materials in the mind before they are committed to paper. The theory as theory is now reasonably complete; but it remains to notice what difficulties may arise in its application, and how its principles may be applied or misapplied in such plans and representative selections as may be taken up for analysis.

In limiting subject. A very common difficulty met in dealing with a subject that is broad in its application, and perhaps abstract in its nature, is to limit and divide it properly. For instance, it might be asked how is one to divide such a subject as "The Problem of the Ages" into two or three heads which shall exhaust it, and at the same time equal it in sum; especially when the subject is perhaps to be treated in a fifteen-minute oration. To state the difficulty is to reveal the source of it. The subject is unlimited; and if the effort is made to discuss it as it stands, either a considerable volume must be written, a very broad partition attempted which shall set forth certain important phases, perhaps themselves too broad for effective treatment, omitting much else that might logically have a place in the discussion,—or perhaps a hap-hazard journey be made from point to point as the writer's fancy may lead him, without regard to relation, sequence, or completeness of view.

Ordinarily in such a case as this, partition is attempted; that is, the enumeration of interesting aspects of the subject, ignoring others. This is legitimate, but as a result a writer may still have too

much ground to cover. He may take as the parts of the subject just given the nature of the problem, and the history of the problem, and be little better off than he was before; or he might take the characteristics and the causes of the problem, and find adequate treatment perfectly feasible. Evidently it all depends upon what the problem of the ages is. That being the case, the first thing to be done is to phrase the subject so as to show what it is.

After that, instead of proceeding at once to partition, it is better to attempt division, as far as division is practicable. Perhaps the problem of the ages is—how to better the condition of the poor. Possible phases of the discussion then are—the nature of that condition, the causes of it, the remedy for it. This, however, is partition rather than division, only the third of these phases being included under the title, strictly speaking. A division would be—how to better the physical condition of the poor (I), the moral condition (II), the intellectual condition (III). A subdivision of each of these would be—the poor with homes (A), the poor without homes (B). Further division might give—the poor in cities(a), the poor in the country (b). Still further division of (a) might give—the poor in great cities (1), the poor in small cities or villages (2).

Now perhaps such a process as this may reveal to the writer that what he really wishes to discuss is not the problem of the ages, but how to improve the physical condition of the homeless poor in great cities. This is mathematically speaking one twenty-fourth as large as the original subject, and it is still ample for all purposes, oratorical or logical, that can be accomplished in a limited time. In fact it may now appear that it is still too large, and that the real question is how to better the physical condition of the homeless poor in great cities in one single particular, perhaps by preventing the spread of contagious disease among them.

If we have thus found out what we wish to discuss, we must rephrase the original subject accordingly, probably reducing its original content by ninety-nine hundredths in the process. We may then resort to partition, and discuss the nature of the particular evil in question, its cause, and its cure; or we may find that we still have space to discuss only one of these points, and that the subject must be phrased again.

Perhaps such a theme as this is more appropriate for an essay than for an oration, but the orator by a similar process may find his theme in the moral or the intellectual division of the original subject. The illustration given is purposely made extreme; but a little attention to the lofty themes which so often stand at the head of col-

lege orations will usually show that if the planning of a treatment seems difficult, the difficulty is to be removed in just this way, by dividing, subdividing, and dividing again and again, confining the discussion to some more or less minute part, and allowing the rest of the imposing but vague and shadowy original whole to wait—till another time.

Students who for any reason have to prepare "orations," so called, are constantly besieging instructors and others for "good subjects," —a good subject ordinarily meaning one that will look well and sound well,—and at the same time they complain that all the good subjects have been used. As an experiment let the student take any hackneyed "good" but outworn subject whatever, and subject it to the process indicated, until he reaches something that is small enough and present enough and new enough in aspect to warrant the attempt to discuss it; and it may after awhile appear that in oratory no less than in narration there is after all no limit to the number of good subjects.

In division and partition In dealing with some subjects, and especially with literary ones, it often seems as though the process of division were entirely inapplicable because the subject is in its nature such that it does not lend itself readily to scientific dissection and classification. But in dealing with any topic, division should first be attempted; and if it be found impracticable, or if it will not lead in the direction in which the writer wishes to go, the theme should first be examined to determine whether a rephrasing of it may not remove the difficulty, and finally as a last resort, partition may be substituted for division. Partition does not allow a writer to introduce anything he chooses under a given theme, but it rather allows him to ignore whatever he chooses, so long as what he does consider is really a part of the theme. And if a subject is indefinite, continued partition may be as effective as continued division in bringing it into convenient shape.

For example a student may wish to write a paper dealing with a recently published book. But to treat every point that might be discussed in relation to the book would be impossible, and to make the attempt would result in a mere lifeless cataloguing of statements. Reducing by partition, he may decide that he will write of style instead a method or moral purpose; reducing again, that he will write of the figurative element instead of the structural one; and perhaps he may then conclude that one particular class of figures, or the figures in one particular section, will be sufficient for his purpose. Or he might treat all the points mentioned, arranging them thus:

T, The Method and Style of.............
- I. Method.
  - A. Development of plot.
  - B. Treatment of character.
- II. Style.
  - A. Vocabulary, and sentence structure.
  - B. Figures of speech.

and his plan be accepted as satisfactory; although he has omitted a large number of possible members from each group, those given belong where they are placed, are clearly distinguished, and are reasonably equal in importance, although A and B (I) do not fully equal I, nor do A and B (II) equal II. If howevei we had a partition of this sort:

T. Review of latest novel by......... ..
- I. Brief biography of author.
- II. Synopsis of the story.
- III. Estimate of its literary merit.

we might justly regard it with suspicion; asking first whether I, II, and III are really parts of T, and second whether they are of the same order of importance; while their sum is evidently so much less than T as to be entirely inadequate.

Whether division or partition be resorted to at first in making a working limitation of the subject, when the points to be treated are actually decided upon, completeness of division or partition should be sought for under those points. That is, if it is determined to treat I, A and B, or II, A and B, in the preceding plan, there is still a division or partition to be made under each of those heads, whether the division is expressed in the plan or not. In practice, at least at first, it is best to elaborate the plan further, entering under each head of the four all the points which a careful reading of the book with reference to that particular matter shows to be noteworthy. This should be done in the discussion even if the plan is carried no further. Ordinarily this will give a partition of the group denoted by a head instead of a division of it, but if that partition is made as complete as the writer's skill will allow, it should be satisfactory.

If in making a partition the writer at any time finds that under any head he has a large number of particulars apparently all of the same rank, he should examine them carefully to see whether they may not be resolved into a few groups, those groups still included under the same principal head. For example under II, B, a writer might accumulate a dozen or more figures of speech. In

that case he might be able to re-group them as figures of comparison and figures of contrast; or as figures intellectual and figures imaginative; in any case seeking for a line of demarcation that shall separate them into classes distinct, and as nearly as may be equal in importance. On the other hand, if the process of partition apparently gives but one sub-head under any group heading, a mistake has been made, and either a companion sub-head must be sought for, or the sub-head phrased as a part of the heading under which it stands.

These principles may be made clearer by a reference to the diagram, page 5 (Fig. 1.) It may be asked: Suppose one has completed the discussion of I in the imaginary plan represented by that diagram, may he not continue until he has discussed A under II, and stop there, leaving II, B and C, and all of III out of account?

The answer is this: If a correct partition has been made, and the writer finds it necessary to go further after completing I, he should at least go entirely through II; and if III is not included in the discussion, or to be included in it, he should rephrase T so as to show that III is not included. Or if he finds that to carry out his intention he needs all of I and only one point under II, he may perhaps conclude that his partition of the theme is faulty. He may then search for a new principle of partition or division of T. Perhaps the former parts were chronological, and what we should have is a division into useful and ornamental, or mental and material. If the new parts of T are called X and Y, then perhaps X will be found to be equivalent to what was formerly A under I, while Y will comprise B under I and A under II. Finally, unless all the other parts of the original plan will fall under the new X and Y, it is still probable that T includes too much, and that it should be rephrased to show the true limit of the discussion.

Another question is: Is it never allowable to wander about through a discussion, taking for instance (see Fig. 1.) I, A, b, following it by II, B, a and III, B, c, and then returning to finish with II, A, b?

There is of course but one answer to this question, although something analogous to this may at times be found in the work of some authors, where it may be excused but not defended. The interest in a work may center in the style and in the personality of the author, and not in its logic; but an illogical arrangement is not therefore of no importance. But before concluding that the plan of a discourse is not logical, it is of course necessary to make sure that it is not based upon a partition made from a peculiar point of view, and correct from that standpoint.

Selection for analysis. We may now test in the analysis of a representative selection, the application of the principles stated. Such an analysis is not often given in text-books because of the amount of space required for the selection itself. The shortest and most convenient one for the writer of this article happens to be that reprinted from "The Nation" on page 144 of Lamont's "Specimens of Exposition." It is here given as much abridged as possible:

THE REAL PROBLEM OF THE UNEMPLOYED.

It is pleasing to note that the general nervousness and fear of last winter in reference to the unemployed have now so largely given way to a season of reflection and analysis. It is no longer enough for a set of men to exhibit themselves as an Army of the Unemployed to inspire sympathy or terror in the staid citizen and make him feel that Congress or the State or city government should "do something." The time has come to cross-examine the unemployed, to ask them how they came into their present evil estate, what work they ever did, and how they came to lose their jobs, and what work they could or would do if it were offered to them. * * * * * * * * * * * * *

We recently had occasion to refer to several interesting reports from American municipalities and charity organizations, which help to a cool understanding of who the chronic unemployed are, and how they came to be so, and now we find strong corroboration of American experience in an article * * * on "The English Municipalities and the Unemployed." The writer * * gives a running account of the reports which seventy-three municipalities made to the Local Government Board in regard to providing work for the unemployed within their bounds. The experiment is no novelty in England. Ever since the labor agitators "threw a scare" into the politicians of both parties in 1885, the demands and threats of the unemployed have been steadily intensifying, and the Local Government Board has issued a circular ever since 1886, urging vestries to give work to idle men. This work was to be of a kind which would not "involve the stigma of pauperism," which "all can perform" which "does not compete with that of other laborers," and "which is not likely to interfere with the resumption of regular employment in their own trades by those who seek it."

The results reported by the seventy-three municipal authorities can not be claimed by the most enthusiastic advocate of state labor as furnishing any water for his mill. In a great majority of cases, the work was unsatisfactorily done, and at an increased cost. The Hanover Square vestry for some weeks kept forty men at work repairing roads. The surveyor in charge reports that "the result has been simply to benefit the men employed at an increased expenditure of £2000 over the annual estimates for labor and material." The Hampstead vestry hired snow-sweepers, and they were reported to be "idle, incapable of hard work and not amenable to discipline," Carpentering work was offered by the Hackney Board of Works, but the "carpenters struck the first day for the trades-union rate of wages." Some of the suffering unemployed were offered work at Finchley at five-pence an hour, but declined it on the ground that "their ordinary wage was six-pence." * * * * Men described in the Government Board circular, "who honestly dread the pauper stigma," do not come within the scope of any of these schemes to provide work by municipalities. One report states that the men belong to "the class of permanently employed," which * * "is the official and Eng-

lish way of stating that they were corner men, loafers." It is also clear from the English experiments that the popular use of the term "unskilled labor" is very inaccurate. [Paragraph then quoted to show that all the forms of labor tried require some skill.]

All these investigations show how idle it is to imagine that any amount of work offered by Government or individuals would solve the problem of the permanently unemployed. * * Mr. — who knows more about the London unemployed than any man living, has justly said: "Lack of work is not really the disease, and the mere provision of it is therefore useless as a cure." In a recent address the Reverend ——— * * made the following absolutely correct statement: "The unemployed, calmly considered, is not an army of willing workers; but is rather a body largely made up of those half employed, those unfit for employment, and those unwilling to be employed." It is clear that the real problem, therefore, is not to provide work, but to make men competent and willing to work. But that is a problem as old as civilization, as old as life itself. Nature's remedy is well known. Work or starve is the sharp dilemma she offers. Society's solution has hitherto been, Support yourself, or go to the work-house, or, if you are diseased or crippled go to an asylum. The new system of coddling is no improvement. It makes men both more incompetent and more unwilling to work. If the State is to interfere at all with the operation of natural law in this matter, it should be in the aim to raise incompetence into fitness, to brand unwillingness as a crime. How to do that is the real problem of the unemployed.

Trial outline of selection. As there are four paragraphs in the selection, the natural impulse is to assign a main head to each paragraph. A preliminary analysis proceeding paragraph by paragraph is as follows:

T. The Real Problem of the Unemployed.
- I. The proper method of solving.
  - A. Not by impulsive action.
  - B. By careful investigation (four points specified, add sub-heads)
- II. Practical application of the method.
  - A. Places.
    1. America; municipalities and charity organizations.
    2. England; seventy-three municipalities.
  - B. Limitations of English experiment.
    1. Work not involving stigma of pauperism.
    2. Work that all can perform.
    3. Work that does not compete with other laborers.
    4. Work that does not interfere with regular employment.
- III. Results of the experiments.
  - A. Facts stated in reports.
    1. In general.
    2. In special cases, (four enumerated, add sub-heads).
  - B. Inferences stated in reports.
    1. Men who fear pauperism not reached.
    2. Men reached were the "permanently unemployed."
    3. Unskilled labor not properly so called.

IV. General inference as to nature of problem.
  A. Not to find work for the unemployed.
  B. To make the unemployed work.
    1. To train the incompetent.
    2. To punish the unwilling.

Examing details of this trial outline, it is first to be noticed that the title is strictly speaking the theme of the fourth paragraph only. The discussion treats of what the real nature of the problem is, and also of how this nature was discovered: and extreme accuracy might rephrase the theme to show that both ideas are included.

Under II, A, the reference to America is so unimportant that it may be omitted from the outline. This will leave II, A, 2 standing alone, and will require that it be incorporated in II, A, But II, A, is of much less importance than II, B, while II, B, and III seem to be coordinate in importance and in logical relation to the common topic. II, A may then be incorporated in II, and the plan be rearranged to bring II, B, and III into co-ordinate relation.

The points under III, B are not so phrased as to show their relation. More exactly stated, the partition intended is probably this—

(III. B) Inference stated in reports.
  1. As to men.
    a. Deserving not helped.
    b. Undeserving not willing to work.
  2 As to labor; term "unskilled" is inaccurate.

The partitions of the other groups are satisfactory and clearly expressed; and it remains to examine the relation of the main headings to each other. Already it has been noticed that III is really coordinate with II, B, and therefore is subordinate to II. That leaves I, II, and IV of the four original heads; but II is clearly more closely related to I than to IV, and we still do not have a satisfactory partion of T. But I and II together describe the process of finding out the nature of the problem, while IV states what was found out. I and II may then be brought together under a common heading, as the first principal division, leaving the original IV to stand as the second one. This gives us finally this general rearrangement, omitting the sub-heads, which have not been changed:

Final outline of selection.

T. The Real Problem of the Unemployed.
  I. How its nature was ascertained.
    A. General nature of satisfactory methods of inquiry.
    B. Application of such a method in seventy-three English municipalities.

1. Limitations of the experiment.
2. Results of the experiment.
   a. Facts stated in reports.
   b. Inferences stated in reports.

II What the real problem is.
   A. Not to find work for the unemployed.
   B. To make the unemployed willing to work.

When to this plan all the omitted sub-heads are added, the analysis is more minute than it perhaps needs to be, except for practice: but in practice work it is hardly possible to be too minute or too precise. The relation of the paragraphing to this plan will be found correct according to the theory that has been stated.

Examination of selected plans. In general, the analysis of an expository selection will show that argument may be mingled with exposition at any step. To show how this may affect the form of the plan, and incidentally to note some faults in plan structure, we may examine parts of the plan of Arnold's essay on Wordsworth, as given on page 5 of Lamont's "Specimens of Exposition."

The first part of the plan in substance is this:

I. Wordsworth is unpopular.
   A. At home,
      a. In his life-time,
         1. His poetry sold poorly;
         2. The public was slow to recognize him;
         3. He was effaced by Scott and Byron;
         4. He was overshadowed by Tennyson.
      b. Since his death,
         1. Coleridge's influence, which once told in his favor, has waned;
         2. In spite of his eulogists, the public has remained cold.
   B. The Continent, which has
      a. Recognized the glory of Newton and Darwin
      b. Does not know Wordsworth;
      c. Yet Continental critics long failed to do justice to Shakespeare and Milton.

Under A, a and b constitute an exact division. The parts under a are reasons for a statement made, and it is not necessary to ask whether they are parts, or divisions; they belong to a logical category different from either. The same is true of 1 and 2 under A, b; in fact this plan shows so much of argument that it might equally well be called a brief.

B is not co-ordinate in form with A, the writer having probably had in mind so to phrase his headings as to make connected sentences of them and combine plan and synopsis in one; a method

ingenious, but having its disadvantages as well as its advantages as may appear. More strictly phrased, the headings would be—

B. On the Continent.
  a. Critics recognized the glory of Newton and Darwin.
  b. They do not know Wordsworth.
  c. (Phrased as before.)

Here is a logical difficulty. c has no place here, either as a part of a whole B or as a reason for a statement B. It is a hint at a new thought, that Wordsworth may sometime become popular on the Continent. Not knowing what to do with the heading, we may refer to the original article, where we find that two long paragraphs intervene between B, b, and B, c, and that c belongs entirely to the next part of the discussion.

The heading of this succeeding part of the plan is—

II. Notwithstanding Wordsworth's unpopularity, he is,
  A. After Shakespeare and Milton the greatest English poet. For in power, in interest, in the qualities which give enduring freshness, he is superior to Spenser, Dryden, Pope. * *

This is intelligible, but it is unsatisfactory either as a plan or as a brief. II by itself is meaningless, and A would be clearer if it were resolved into two parts; one a reason for II, and the other a reason for that reason. Rephrasing, and bringing in c from B preceding, we have--

II. Wordsworth deserves to be popular.
  A. His unpopularity on the Continent no disproof.
    a. Shakespeare and Milton were once unpopular on the Continent.
  B. He is the greatest English poet.
    a. He is superior in enduring freshness to all others.
      1. To Spenser
      2. To Dryden, etc.

According to this restatement, we now have a heading, a under A, standing alone. In an expository passage, this would be incorrect, but in argument, a single reason may often support a proposition and the point illustrates a difference between a plan and a brief.

ARGUMENT.

Processes Involved A student must then be prepared to deal with argument at any stage of an analysis, and often analysis shows that what is called exposition is purely argument, perhaps with implications substituted for direct statements. On the other hand, if argument is often found in exposition, exposition is no less often a part of argument. Many of the processes involved are the same in both ar-

gument and exposition; the limiting of the subject, the defining or explaining of its terms, and even in a certain sense the partition of the discussion.

What is required in the analysis But while the essential process of exposition is division or partition, supplemented by definition, the essential process of argument is of course proof. Analysis in exposition has to determine what are parts of a given whole, and the relation of part to whole is practically the only one to be considered. Analysis in argument has to determine what reasons may justify a given proposition, and the relations involved are numerous and often complex.

As the subject of argument is not something to be divided but something to be proved, it may not be an idea expressed perhaps by a single term or a phrase, but must be a proposition. This proposition, like the theme of an exposition, must be limited until it shall not include too much for the proposed time and space of the discussion; and must be phrased so that its meaning shall be as far as possible definite, unambiguous, and indisputable. If it cannot be so phrased, to determine its meaning is the office of exposition, preliminary to the argument.

Propositions are either self-evident, accepted, or doubtful. Those of the last class are properly subjects of argument as their truth may be either affirmed or denied, the other classes being used in proving them.

Having selected a proper subject, limited and phrased it, the next step in analysis is to determine what facts or propositions will best aid in determining its truth or falsity. The number of these is determined by circumstances, and may range from one to several. Some or all of these may require to be supported by other facts or propositions in their turn; and these other propositions may require to be again supported. Some of the facts or propositions employed may aid the process by showing the untruth of opposing propositions. When each line of support ends in an accepted or self-evident truth, the process is theoretically complete: while in practice it mav end before this stage is reached.

What is required in the brief. The outline which indicates the steps of the process is called a brief. At the head of the brief should stand the proposition to be proved, so phrased, using a negative if necessary, that its truth may be affirmed instead of denied, and conforming to the other requirements stated. It may be marked P, to distinguish it from the theme of an exposition.

The main headings of the brief are not parts of P, but they are propositions employed to prove P through some one of the inductive or deductive processes to be classified; and they should be as fully phrased as P itself. The subordinate headings again are propositions employed to prove the propositions standing as main headings. In deduction, one proposition may be sufficient for the proof of another; while in induction a considerable number may be required to make the truth of another reasonably certain. A general rule is that only as many should be used in any single case as may be necessary to establish the proposition at issue. In induction, where enumeration of facts is often argument, the headings may often for convenience be expressed in abbreviated form as phrases or terms; but when so abbreviated their full propositional meaning should be fully evident, and if there is a possibility of misconstruction, the proposition should be fully expressed. Finally, every proposition should have as nearly as possible the form in the brief which it must take when actually used in logical process.

With these exceptions, a brief is constructed according to the same principles as is a plan. Co-ordinate headings should when practicable be similar in form, and clearly distinguished from one another. Especially important is it that in a single heading should not be massed together principal and subordinate arguments and propositions; a rule often violated in practice for the convenience of the brief-maker, but at the risk of error, and at the sacrifice of the convenience of the brief-analyzer. Finally by numerals, or indentations, or both, the relations of all parts of the brief should be shown; the numerals employed as in a plan.

The Amplification. In amplification, some other title may be substituted for the proposition to be proved, in case it is for any reason advisable not to declare in advance of the argument which side of a given proposition is to be defended. In such a case it is best to put the proposition as a question; in all other cases the proposition should be stated as it is in the brief. The amplification proper requires the defining of terms and the explaining of propositions whenever this is necessary, but it consists essentially of showing in full how the subordinate arguments prove their principals in each successive case; or what logical relations subsist between each subordinate and its principals. It usually concludes with a summary, which may be defined as a synopsis of the principal arguments; those designated by the main headings.

Paragraphing. In the paragraphing of the amplified argument the principles that were stated with reference to the plan and its amplification (page 9, Fig. 3), hold good with very slight modification. If the brief is of this form—

P .... (1).
  I .... (2).
    A .... (3).
      a .... (4).
    B .... (5).
      a .... (6).
  II .... (7).
    A .... (8).

we shall ordinarily find in the discussion a single paragraph corresponding to (1), the definition or explanation of P. (2) in the discussion may stand alone, or with it may be grouped (3), or (3) and (4); but if we go further and add (5) we should add (6) also. (7) and (8) may be grouped together, but nothing preceding that group can be added to it, unless the whole of I is added. Every proposition with its sub-propositions may be regarded as a group, and as in exposition, the general principle is that parts of different groups must not be brought into the same paragraph.

Diagram why necessary. It was stated (page 5) that a well constructed plan of a pure exposition gives all the information as to its nature; content, and logical structure that the analyst can desire, and that no diagram is necessary. This would be true of a brief also, if there were but a single logical relation that could exist between proposition and proof. Instead of a single relation, there are in argument a considerable number, and these not of equal importance, but requiring to be examined and estimated independently, that their relative weight may be determined: relations of cause and effect, of resemblance, of opposition, of contradiction and of inclusion. In a brief it can be shown only that some relation exists: what that relation is, and how it aids in determining the truth of the principal proposition must be shown by some additional device. To add foot-notes in parenthesis for this purpose is awkward: to exhibit an argument by writing out in full all syllogisms and chains of reasoning is, unless the argument is very short and simple, infinitely confusing. It is precisely at this point, when called upon to deal with extended chains of reasoning, that a class pursuing the study of logical analysis begins to find the work so difficult that it perhaps gives it up entirely. If by some simple device, the structure of a direct argument or a refutation, in any form of either, can be represented to

the eye without the intervention of a mass of words, it will evidently be of advantage.

To show that a brief does not explain an argument sufficiently for all purposes, and that thorough analysis is necessary to ensure its correctness, a brief is subjoined, from page 123 of Scott and Denney's "Paragraph-Writing."

P. An international copyright law should be secured.
  A. The law of property protection a fundamental law of society.
    1. A man has the right to protect his own property.
    2. He is entitled to such protection from the government,
  B. The products of one's thought are property
    1. Because they are the result of labor, and therefore valuable.
    2. This is recognized by every government in respect to its own citizens.
  C Such property should receive international protection.
    1. Since, without it, an author's property does not receive from foreign countries the protection which they accord to other species of property. The author is singled out to be cheated of his rights Examples: "Uncle Tom's Cabin," Bancroft's "United States," and others.
    2. In the absence of such protection an author does not receive equal treatment with other laborers.
  D. Special application to American authors.

Before the argument here presented can be understood as fully as is essential if refutation is to be attempted, it is necessary to know by virtue of what relation or process A, B, and C respectively aid in proving P; how A, 1 and A, 2 prove A and so on. Further analysis is therefore necessary, no matter how correct the brief may be. As to its form, D should also be, like A, B, and C, an argument supporting P. This it evidently is not; but is rather the second of two parts of the discussion: the first the argument, the second the application; or it may be brought into relation to the argument in a way to be hereinafter explained, but not such a relation as its place here would indicate. C, 1, contains a mass of material which should be sifted and classified; and the process to be carried out later will show that one part of it belongs elsewhere and that another part of it is superfluous. It will also appear that C itself is not phrased as it is used in logical process, and that it may be so phrased without violating any rules of grammar or rhetoric; rules which the brief-maker should respect, although the formal logician may not. Close analysis will show that other important changes are necessary to make this a model brief. If this close analysis had preceded the making of the brief, it is a fair inference that the brief would have been a better one. And after a student

has toiled to reduce a badly stated argument to correct logical form, he himself is not likely to make such mistakes as those he may have discovered.

Explanation of system of diagrams. In the close analysis of complicated arguments, a system of diagrams has been found of very great assistance as far as it has been tested. It is based upon a broad working classification of forms of argument, and aims to represent them to the eye, to distinguish them from each other whenever this is necessary, and to represent all the logical processes in a single argument, no matter how complex, by a single map.

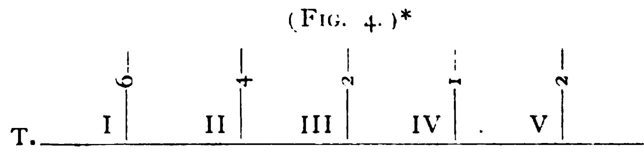
Induction. Inductive processes may be roughly classified as follows, the actual classification being immaterial:

I. Reasoning based on causal relation.
- A. A priori; cause to effect 1
- B. A posteriori; effect to cause 2
- C. Cause to cause, or effect to effect.
  - a. Argument from authority 3
  - b. Argument from testimony 4
  - c. Argument from attendant circumstance 5

II. Reasoning based on relation of resemblance.
- A. Argument from example 6
- B. Argument from analogy 7

All that is material in classifying for this purpose is that the inductive arguments shall be arranged as nearly as possible in order of their strength, and numbered, as at the right of the page. In all these forms there is one essential feature that distinguishes them from deductive arguments; namely, that in each facts are employed to support a proposition that is more general in its nature than any of the facts used in supporting it. This is represented to the eye by drawing a line to represent the general proposition, and from it at an angle other lines to represent the particular facts used in proof. To distinguish one class of particular from another, when this is necessary, the figure opposite it in the table just given may be placed in the line. Upon each of these lines is placed the numeral which denotes the corresponding proposition in the brief.

(FIG. 4.)*



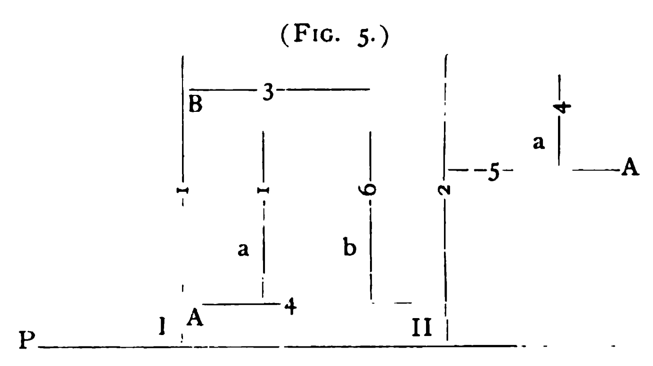
*In practice, the lines denoting inductive processes are drawn at an oblique angle from the line denoting the conclusion, while all lines used to denote deductive processes are drawn at right angles. This serves to distinguish the two processes instantly, and to lessen the danger of mistaking the meaning of a diagram. In these pages, however, some of the diagrams are made right-angled, for convenience in type-composition, as the processes are still clearly distinguished.

In the brief it may happen that some at least of the propositions I, II, III, IV, V are in their turn supported by other arguments; a thing not impossible even when they are used inductively themselves. If in their turn supported by induction, so that for instance we have a brief in form like this, and supposed to be inductive throughout,—

P.....................................
    I.....................(a priori).
        A.............(testimony).
            a........(a priori).
            b.........(example).
        B.............(authority).
    II....................(a posteriori).
        A.............(circumstance).
            a........(testimony).

we may represent this theoretical brief, without considering whether in fact such arguments could stand in such a relation as that indicated, by a diagram of this form:

(Fig. 5.)



The figures in the lines are sometimes necessary when the relative weight of opposing arguments is to be determined, as in debate. Ordinarily they may be omitted.

In practice, it sometimes happens that arguments may be regarded as either inductive or deductive. While it may happen to be immaterial which way such an argument is analyzed, and the simplest method should be chosen, the better method or the correct one will usually be obvious when the related arguments are considered. If there is a choice, it is in general better to regard an argument as inductive.

Deduction. Deductive argument, in which we proceed from the more general truth to the less general or to the particular truth, employs as its instrument some form of syllogism. Syllogisms may be broadly classified as categorical, hypothetical, and alternative; but as the hypothetical syllogism may usually be stated in cate-

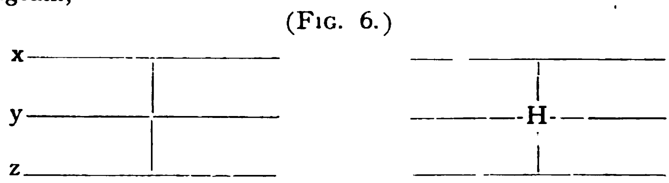
gorical form, there are for practical purposes two forms to be represented in diagram.

Categorical syllogism. The more important of these, the categorical syllogism, is in form such as to suggest a method of representing it. Three propositions,—two premises and a conclusion,—stated in the conventional way,—

All A is some B.
All B is some C
Therefore, All A is some C,—

call for three horizontal lines; and the relation of these three propositions may be indicated by a cross vertical line. Thus we have, in diagram,—

(Fig. 6.)



line x standing for the major premise, y for the minor premise, and z for the conclusion. Such of these as appear in the brief will be designated by the numerals assigned them in the brief; while such as are merely implied in the brief will be left without a numeral. Should it be for any reason necessary to show that a syllogism is really hypothetical, a letter H may be placed at the central intersection of the lines as in the right hand figure. An alternative syllogism of two alternatives, a reductio ad absurdum, and each horn of a dilemma, may on occasion be represented by the same three lines, and denoted by the letters A, R, and D respectively, placed at the center of the figure.

Alternative syllogism. The alternative syllogism whose major premise enumerates more than two alternatives, and whose minor premise denies all but one of the alternatives, is more troublesome. Even if it contains but two alternatives, it is so essentially different from the categorical syllogism that a different method of representing it is often desirable. Moreover, as it may involve denial as an essential part of its process, and as denial is the motive of refutation, some method of representing in it a refuted proposition is often convenient.

Following is a diagram which aims to meet these requirements as to such a syllogism of two alternatives; of the form: Either A is B or A is C; A is not C; therefore A is B. First, a line is drawn (Fig. 7) divided into two parts by a heavy cross stroke, and one of these parts serrated.

(FIG. 7.)

A is B | A is C

The smooth part of the line represents the true alternative; the serrated part the false one. The intersection of the short vertical line with the horizontal one may be regarded as the point where the false alternative is as it were broken off from the true one.

But in denying an alternative we must employ proof to substantiate the denial. How shall this proof be represented in the diagram? The line standing for the refuted alternative is serrated, but to attach directly the argument employed in refuting it would imply that the argument used in the refutation is itself a part of the refuted structure. There is needed a general means of indicating to the eye the refutation of a proposition through the proof of its opposite or its contradictory.

The following tentative method has been found to answer as far as tested. Its essential feature is the introduction of an inverted V as a fulcrum under the line denoting a proposition, to distinguish its positive side from its negative, contradictory, or opposite side.

(FIG. 8.)

(x) A is B | A is C

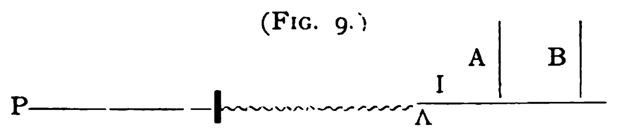
(y) A is B | A is C A is | not C |

Λ F

Line (x) merely represents the two alternatives before discussion begins. Lines (y) constitute the actual diagram as used in practice; the serrated line representing the overthrown alternative, and the straight line at the right the contradictory (or the opposite) of it, which is represented as supported by two inductive arguments. The false alternative is supposed to be broken away from its connection with the true one by the weight applied to its contradictory on the other side of the fulcrum F.

In actual analysis, the lines are as before marked by the numerals which in the brief designate the propositions represented. If the proposition: A is B, is the proposition to be proved, it will be marked P. In the brief, the proposition: A is not C, would probably appear as the main heading under P, marked I, followed in its turn by the two inductions, marked A and B. The actual diagram would then be lettered as follows:

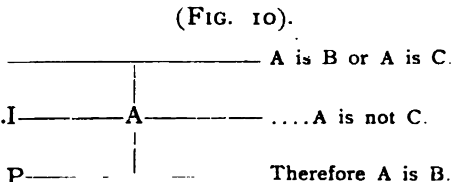
(FIG. 9.)



and its meaning in relation to the brief is clear.

If there are but two alternatives, the alternative syllogism may often be more conveniently represented by such a diagram as that given for the categorical syllogism, marked for distinction with a capital A as here shown:

(FIG. 10).

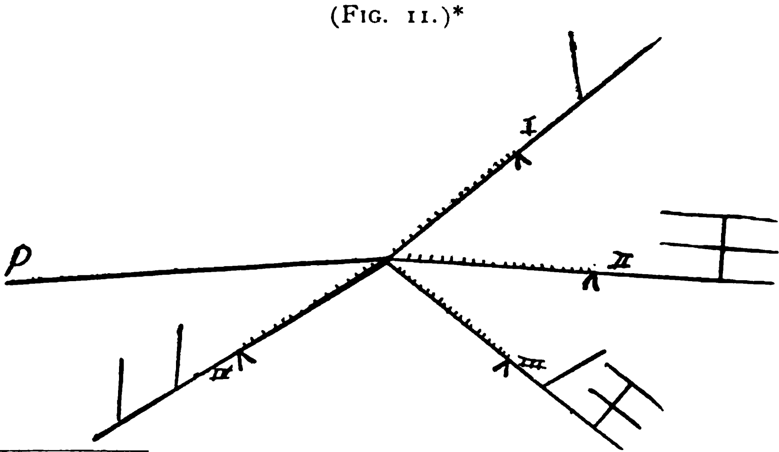


There remains the alternative syllogism of several alternatives, all of them but one being disproved in turn. The diagram follows from the first of the two methods given, and in appearance it is somewhat alarming. If for instance the alternatives are five,—A is either B or C or D or E or F,—we should probably have a brief of this form,—

P. A is B.
I. A is not C.
(Proof.)
II. A is not D.
(Proof.)
III. A is not E; and so on till the alternatives are exhausted,

and in diagram this may be represented as follows: *

(FIG. 11.)*

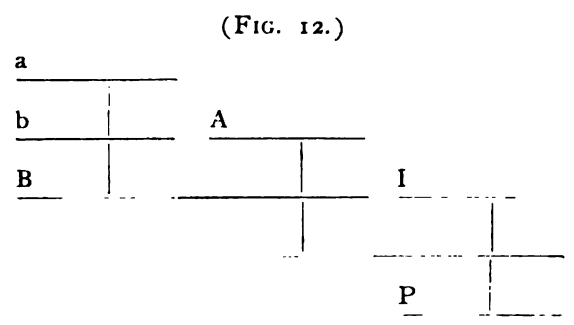


*This reasoning is often refuted by pointing out that an alternative has been overlooked. To represent this in diagram, draw an additional line, meeting the others at the common point. This stands for the omitted alternative. P is now in doubt, and the line representing it may be serrated. (See page 31 ff.)

the lines upon I, II, III, and IV representing supposed arguments, some deductive and some inductive.

Sorites. Having these several devices for respresenting individual steps in reasoning, we may next consider how to represent a chain of reasoning. How to do this in induction is shown by Fig. 5 (p. 25.) In deduction, the law of the sorites is that the conclusion of each syllogism shall be the minor premise of the next. In diagram, this is—

(FIG. 12.)

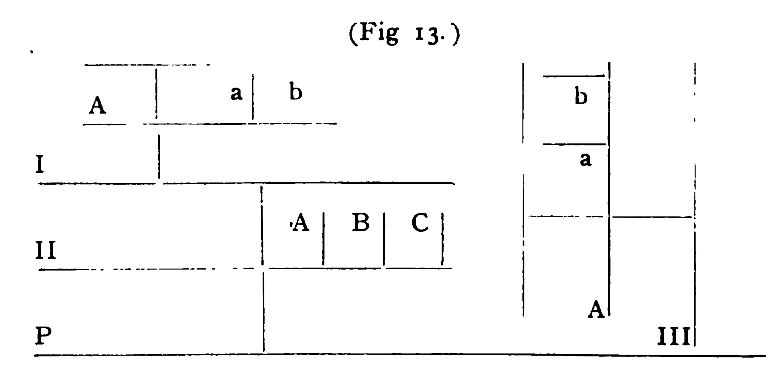


and a brief corresponding in form and lettering is this:

P..
I ....
A...
B...
a ....
b ....

How this correspondence is possible will appear when we proceed to make actual analyses of briefs and arguments; the minor premise corresponding to the major I is supposed not to be stated in the brief.

In practice, however, it will be found that writers and speakers are not careful to follow the formal law of the text-books. They are quite likely to use a conclusion as a major premise instead of a minor; to use two conclusions as major and minor respectively, and to draw a new conclusion from them; to alternate induction and deduction, or to use them side by side; or to base either upon the other. Some of the contingencies that thus arise are here represented.



(Fig 13.)

In this supposed argument, the leading proposition, P, is supported by an induction III, and by a syllogism the premises of which are I and II. III, though used inductively, is itself the conclusion of a syllogism, the minor premise of which is A, supported by inductions a and b. II is supported by three inductions, A, B, and C; and I by a syllogism with minor A, supported by inductions a and b. Any proposition here represented as ultimate may of course be thought of as supported by further argument, until self-evident or accepted truths are reached.

In the brief, such an argument would have this form:

- P..........
  - I..........
    - A..........
      - a..........
      - b..........
  - II..........
    - A..........
    - B..........
    - C..........
  - III..........
    - A..........
      - a..........
      - b..........

and it becomes apparent why in such a case a diagram is superior to the brief or to any arrangement of syllogisms as a guide to the comprehension of what is actually going on.

Refutation. But we are not yet ready to proceed to test our method in the actual analysis of briefs or arguments. In practice we shall meet everywhere with refutation, and we must first determine how to deal with it. Refutation proceeds by either of two general methods; it destroys by pointing out fallacies or errors of process an argument already advanced, or it builds up a new argument to prove the contradictory or oftener the opposite of the proposition. The first method may be termed refutation proper; the

second, refutation by opposed direct argument. The distinction between these may be illustrated by tracing an argument from its beginning. Fig. 14 represents a proposition before the discussion of it

(Fig. 14.)

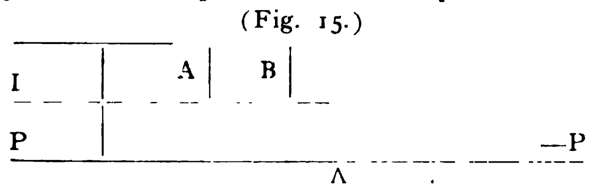
P P

A

begins, resting across the argumentative fulcrum; one end representing the affirmative, the other negative. One end is usually heavier, having the presumption in its favor; the burden of proof, or the necessity of beginning the argument rests upon the other end; and in debate, as it is conventional for the affirmative to begin the discussion, the proposition should be so stated that the burden of proof may rest upon the affirmative. In the figure, therefore, P represents the affirmative of the proposition, and —P the negative. The line —P may be made heavier to indicate that the presumption is upon that side.

We will suppose that the affirmative begins its work by erecting such a logical structure upon its side as is represented in Fig. 15.

(Fig. 15.)



The proposition may now be regarded as tilted the other way by a syllogism resting upon P, its minor supported by two inductions. What shall the negative now do? Clearly it may either attempt to remove the structure which the affirmative has erected, or to erect another structure and if possible a more weighty one upon its own side, —P. Its wisest course will be to do both, beginning with the first; if the second only is attempted, there may be doubt as to which side is really the heavier.

If then, the affirmative argument is to be attacked, some one of the following possibilities may be open to the negative:

First. It may attack the syllogism upon P by showing that it involves a fallacious process. There may be an error in distribution of terms, or there may be two particular premises, or two negative premises, or some other purely structural defect. This may be indicated in diagram by serrating the vertical line, showing that though the premises may be true, the conclusion does not follow. See Fig 16.

(FIG. 16.)

I A B

P

Second. It may weaken I by showing fallacious processes in A and B, which support it; for example, by showing that a causal relation does not exist where it has been assumed. This may be indicated in diagram by serrating the lines A and B (Fig. 17).

Third. It may attack the major premise of the syllogism by reductio ad absurdum, showing that the same major with a new minor will lead to an absurd conclusion. This, as it shows that the major premise is not in all cases true, is in effect proving its contradictory. In diagram the new syllogism may be represented as dependent, on the other side of a fulcrum, and the positive part of the major premise may be serrated (Fig. 18).*

*A fuller explanation of the meaning of the diagrams of reductio ad absurdum and dilemma may be of convenience. The use of reductio ad absurdum may be thus illustrated. Given a major that is to be overthrown because it includes too much, a minor is to be found for it that will lead to an absurd conclusion. Such a syllogism with accompanying diagram is this:

(Fig. 18a.)

z. Whatever does harm should be abolished.
y. The use of electricity does harm.
x. The use of electricity should be abolished.

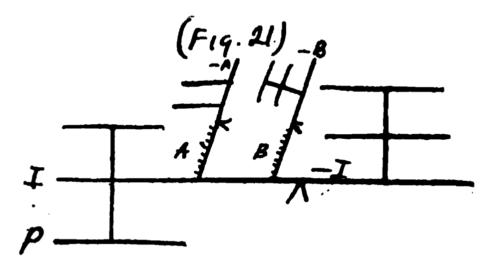
This syllogism and the diagram (18a) show the apparent form of the reasoning: but its true logical value and application are obtained by inverting the syllogism, substituting for the absurd proposition its contradictory, and from it as major, using the same minor, obtaining a conclusion that in effect contradicts the former major premise. The only change required in the diagram is the inserting of the fulcrum, and the serrating of the line representing the original major premise

(Fig. 18b.)

x. The use of electricity should not be abolished.
y. The use of electricity does harm (sometimes)
z. One thing that does harm should not be abolished.

The numerals assigned to these lines in the diagram should have minus signs when the process is, as is supposed in this case, used in answer to an affirmative argument.

Fourth. It may attack the same major premise by proving its opposite or contradictory by direct opposed argument, the second of the two methods of refutation. This is represented in Fig. 19.

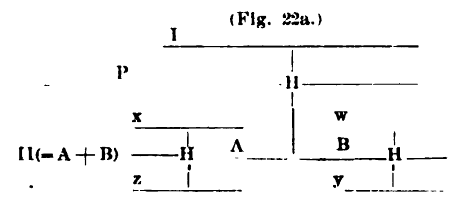


Fifth. It may attack I by direct opposed argument, disregarding A and B. This will render the truth of I merely doubtful, unless the new opposed argument is clearly much more weighty than A and B. This method is represented in Fig. 20.

Sixth. It may also attack A and B by direct opposed argument.

Examining the dilemma (see next page) in the same way, its apparent movement, which we may call a downward movement, is this in syllogism and diagram; propositions and lines corresponding being as before indicated by the same letters:

(Fig. 22a.)



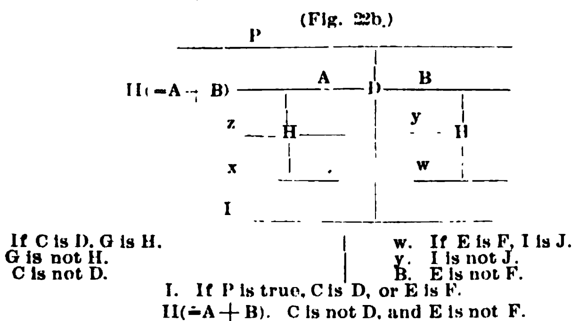
I. If P is true, either C is D, or E is F.
P. But P is true (it is supposed).
II(-A+B). Therefore C is D or E is F.

x. But if C is D, G is H.	w. Or if E is F, I is J.
A. Suppose that C is D.	B. Suppose that E is F.
z. G is H is absurd or impossible.	y. I is J is absurd or impossible.

The general conclusion is that if we reach only absurd or impossible results through our original assumption, it must be that P is not true.

The actual reasoning is again an inversion of the apparent reasoning; the minors and conclusions interchanged, necessitating a change in the form of the diagram.

(Fig. 22b.)



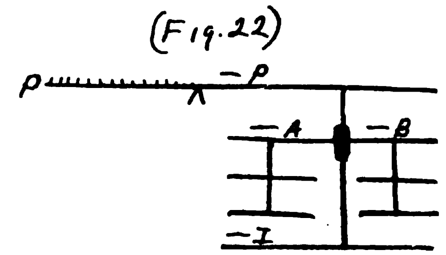
x. If C is D, G is H.	w. If E is F, I is J.
z. G is not H.	y. I is not J.
A. C is not D.	B. E is not F.

I. If P is true, C is D, or E is F.
II(-A+B). C is not D, and E is not F.
P. Therefore P is not true.

We have, therefore, as in the case of reductio ad absurdum, actually proved the contradictory of the proposition in question, and in the diagram the fulcrum and the serrated line come into play, while if the argument is in answer to an affirmative one, minus signs are used throughout; all as indicated in Fig. 22.

The diagrams indicating both processes might, of course, be placed above the line indicating the conclusion as in the case of other syllogisms; but if left below they serve to indicate what is true; that the apparent reasoning moves from that conclusion, while the real reasoning moves toward it; and are thus distinguished from the diagrams of other processes.

This alone will merely leave I unsupported; but, combined with the fifth method, it will overthrow I entirely. The combination of the fifth and sixth methods is represented in Fig. 21.



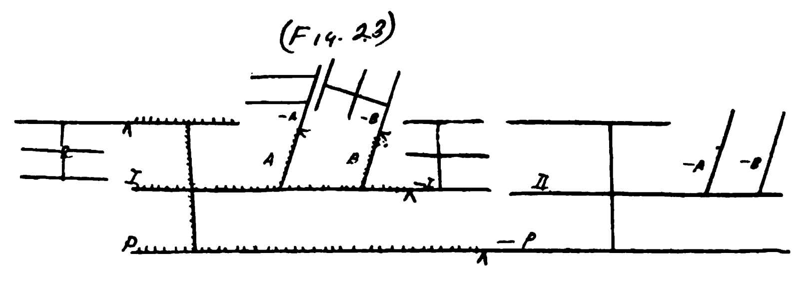
Seventh. Any or all of the preceding methods may be combined, if such combination is possible; and diagrams combined to correspond.

Eighth. It may, in some instances, be able to overthrow P by reducing it to alternatives, and employing the dilemma. A theoretical method of representing this in diagram, which has not been sufficiently tested in practice to determine whether it will serve in all cases, is shown in Fig. 22. The theoretical form of the corresponding brief is this; minus signs being prefixed to the numerals of both brief and diagram to show that the argument belongs to the negative:

—P. A is not B; (that is, P is not true.)
—I. When A is B, C is D, or E is F.
—A. C is not D.
—B. E is not F.

Ninth. It may proceed to attack P by direct opposed argument in support of —P. In diagram the argument is represented in the usual way, except that minus signs are prefixed to the numerals used. Minus signs should be used in all parts of the diagram that stand for negative arguments, not simply for an algebraic reason but to designate more clearly their office; and it may sometimes be convenient to use minus signs before the numerals of the brief itself, for a similar purpose.

If the negative has been able to do all these things here enumerated, then at the conclusion of its work, a complete diagram of what has been done will be this:



representing of course an extreme case, since an argument is not usually so badly demoralized by an opponent as the affirmative is here supposed to be.

It is to be noted that even if the entire structure upon P is destroyed, the work of the negative is not completed until it has erected an opposing structure upon —P; until it has added direct opposed argument to refutation. If this is not done, a very slight additional argument from the affirmative may turn the balance again in its favor. For the same reason, at every stage of the refutation the negative should whenever possible introduce direct opposed argument to prove the contradictory or opposite of each affirmative proposition. If this is not done, the affirmative may by a new process make use of any proposition not actually disproved, and regain its lost ground. For instance, the negative may show fallacious process in the main syllogism on P, but unless it overthrows the premises, the affirmative may correct the process. The negative may overthrow A and B supporting I, but unless it also proves —I, the affirmative may still maintain I by introducing a single new argument in support.

In refutation, it often becomes necessary to formulate a proposition left unstated by the other side, and hence lacking a numeral to designate it. Such a proposition in the preceding diagram is the major used with I and P. As it is logically, co-ordinate with I, it may sometimes be denoted by I with a subscript; and a zero subscript (I_0) has been found convenient, zero denoting implication.

Application of principles stated.

We may now proceed to make application of this general method in the analysis of specimen briefs and full arguments. For convenience we may take as the first example for analysis the brief already given (page 23). This as already stated, requires to be reconstructed, and its analysis is correspondingly more difficult, though the underlying argument is valid. The chief errors are in co-ordination, and in statement of propositions. The greatest confusion exists in C. As given it is practically identical with P itself, all that is necessary to pass from one to the other being an equivalent proposition, as shown below. A and B are really subordinate to C; and while B is co-ordinate with the subheads of C, A is still further subordinate.

In the analysis of a brief.

If D is intended to be a part of the argument, it may be either a conclusion from all that precedes, or the second of two independent

arguments to prove P. In the first case, it may itself be placed at the head of the brief in place of the original P, in the form,—

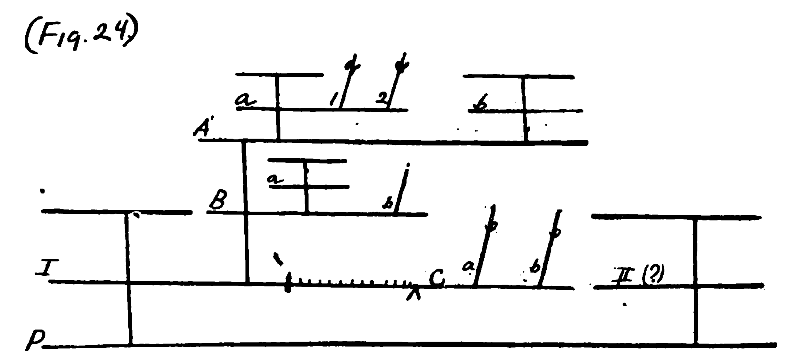
> P. An international copyright law should be secured for the benefit of American authors;—

but the second alternative has been accepted in reconstructing the brief, as involving less of change in the language and arrangement of the original, and as being still correct, if D has merely an expository significance. To accomplish this reconstruction, it is necessary to begin by reducing to diagram all parts of the brief that are evidently correct as they stand. The effort to fit these incomplete diagrams together into a logical whole and at the same time to bring into logical relation the propositions represented will show immediately what reconstruction is necessary and where; and it becomes comparatively easy to rearrange and rephrase the brief in accordance with the exact logical structure as shown by the complete diagram. It may happen that a proposition as used in a chain of reasoning must be expressed in a form that is rhetorically awkward; and in such a case, a logical equivalent as like it as possible may be used for it in the brief.

The reconstructed brief here given may be regarded as one proposed solution of the problems presented by the original. It is not necessarily the only solution possible; and whether it is really a correct one or not is determined by the intent of the author of the original one.

P. An international copyright law should be secured.
- I. The product of an author's thought should receive international proprotection.
  - A. All property should receive international protection.
    - a Property protection is a fundamental law of society.
      - 1. A man has the right to protect his own property.
      - 2. He is entitled to protection from his government.
    - b. Some property now receives international protection. (This is C, 1, in the original; C, 2, being equivalent, and therefore superfluous.)
  - B. The product of an author's thought is property.
    - a. Because it has value as the result of labor.
    - b. Because every government recognizes it as such, of its own citizens,
  - C. Other than international protection is insufficient. (This is part of C, 1, in the original.)
    - a. Example of "Uncle Tom's Cabin."
    - b. Example of Bancroft's "United States." Etc.
- II. The need of American authors is an especial one. (No argument subjoined; perhaps not intended to be part of the argument.)

Following is the corresponding diagram:



To make clear its meaning, each detail of the argument as expressed and implied in the brief is subjoined, in the order of the brief.*

If II has the meaning that has been conjectured for it, it is the minor of a syllogism whose implied major (II_0)† is—

A law that is especially needed for the protection of American authors should be secured.

II may be enunciated thus—

An international copyright law is especially needed for the property protection of American authors,

whence P follows as a conclusion.

The syllogism, I_0, I, P, is this:

I_0. An international copyright law is an international law to protect the thought product of authors.

I. An international law to protect the product of an author's thought should be secured.

P. An international copyright law should be secured.

This major, as already stated, is practically a statement of equivalence. The syllogism which supports I is—

Major. A. International law to protect all property should be secured. (This phrasing of A and I is used to bring them into formal agreement with P.)

Minor. B. The product of an author's thought is property.

B is supported by two arguments. The first may be thus syllogized:

Major. a_0. Whatever has value as the result of labor is property.

Minor. a. The product of an author's thought has value as the result of labor.

Argument b under B may conveniently be regarded as a posteriori, stating a result from which B may be inferred as a cause; that is, if a government recognizes a thing as property, it must be because it *is* property.

* If the diagram were inverted, it would correspond in position to the brief; but its present position may be regarded as picturing the development of the argument.

† A zero subscript designates an implied premise. (See page 35.)

The first argument supporting A is—

Major. a_o. A fundamental law of society should be secured as international law.
Minor. a. The protection of all property is a fundamental law of society.
Conclusion. A. The protection of all property should be secured as international law.*

The second argument supporting A is—

b_o. Protection accorded to some property should be accorded to all.
b. Some property is protected by international law.
A. All property should be protected by international law.**

The two arguments supporting a under A may be regarded as a posteriori. Because property protection is a fundamental law of society, it follows as a result that a man may protect his own property, or call on the government for aid in protecting it. As the results are acknowledged to be true, the cause must be true.

Argument C answers an anticipated objection, that there already exists protection for the product of an author's property. This objection is in effect suggesting an alternative for I. It is represented in the diagram in the manner already explained, and is refuted as there shown, by the citation of examples. In the diagram, the serrated line stands for the supposed alternative,—

Present protection (other than international) for an author's property is sufficient.

while C stands for the contradictory of this proposition, and a and b for the supporting examples, all as expressed in the brief.†

Selection from Macaulay. We may now proceed to the analysis of a representative argumentative selection, constructing both brief and diagram. For this purpose the following passages are abridged from Macaulay's "Essay on Hallam's Constitutional History," as given in Genung's "Handbook of Rhetorical Analysis," page 266.

*It will be noted that A has been used in three distinct forms; but these are the same in meaning, and are used to avoid doing violence to the English. The following syllogism gives A in the form in which it was last used:

a_o International law to maintain the fundamental law of society should be secured
a. To protect all property is a fundamental law of society.
A. International law to protect all property should be secured.

** Restated as was the preceding syllogism:

b_o. Law that exists for some property should be secured for all.
b. International law for the protection of some property exists.
A. International law to protect all property should be secured,

†As there are but two alternatives, this argument and its diagram may be given in this form also, which may be preferred:

C_o. An author's thought product should receive protection either by international law or otherwise.

C. It does not (or can not) receive protection otherwise. (a and b as before.)

I. It should receive international protection.

(Fig. 24a)

C A a b I

It is vehemently maintained by some writers of the present day that Elizabeth persecuted neither Papists nor Puritans as such, and that the severe measures which she occasionally adopted were dictated, not by religious intolerance, but by political necessity. * * * The title of the Queen, they say, was annulled by the Pope; her throne was given to another; her subjects were incited to rebellion; her life was menaced; every Catholic was bound in conscience to be a traitor; it was, therefore, against traitors, not against Catholics, that the penal laws were enacted. * * *

We will state as concisely as possible the substance of some of these laws. As soon as Elizabeth ascended the throne, and before the least hostility to her government had been shown by the Catholic population, an act passed prohibiting the celebration of the rites of the Romish church. * * *

A law was next made, in 1562, enacting that all who had ever graduated at the universities or received holy orders, all lawyers and magistrates, should take the oath of supremacy when tendered to them. * * * After the lapse of three months * * if it were again refused, the recusant was guilty of high treason. * * * What circumstances called for this extraordinary rigor? There might be disaffection among the Catholics. The prohibition of their worship would naturally produce it. But it is from their situation, not from their conduct, from the wrongs which they had suffered, not from those which they had committed, that the existence of discontent among them must be inferred. There were libels, no doubt, and prophecies, and rumors, and suspicions; strange grounds for a law inflicting capital penalties, *ex post facto*, on a large body of men. * * *

Eight years later, the bull of Pius deposing Elizabeth, produced a third law. This law, to which alone, as we conceive, the defence now under our consideration can apply, provides that if any Catholic shall convert a Protestant to the Romish church, they shall both suffer death as for high treason. * * *

In the first place, the arguments which are urged in favor of Elizabeth apply with much greater force to the case of her sister Mary. The Catholics did not, at the time of Elizabeth's accession, rise in arms to seat a Pretender on her throne. But before Mary had given or could give provocation, the most distinguished Protestants attempted to set aside her rights in favor of the Lady Jane. That attempt, and the subsequent insurrection of Wyatt, furnished at least as good a plea for the burning of Protestants as the conspiracies against Elizabeth furnish for the hanging and embowelling of Papists.

The fact is that both pleas are worthless alike. If such arguments are to pass current, it will be easy to prove that there never was such a thing as religious persecution since the creation. For there never was a religious persecution in which some odious crime was not, justly or unjustly, said to be obviously deducible from the doctrines of the persecuted party. We might say that the Cæsars did not persecute the Christians. * * * We might say that the massacre of St. Bartholomew was intended to extirpate, not a religious sect, but a political party. * * *

To punish a man because he has committed a crime, or because he is believed, though unjustly, to have committed a crime, is not persecution. * * * When Elizabeth put Ballard and Babington to death, she was not persecuting. * * * But to argue that because a man is a Catholic he must think it right to murder a heretical sovereign, and that because he thinks it right he will attempt to do it, and then to found on this conclusion a law for punishing him as if he had done it, is plain persecution.

If, indeed, all men reasoned in the same manner on the same data, and always

did what they thought it their duty to do, this mode of dispensing punishment might be extremely judicious. But as people who agree about premises often disagree about conclusions, and as no man in the world acts up to his own standard of right, there are two enormous gaps in the logic by which alone penalties for opinions can be defended. The doctrine of reprobation, in the judgment of many able men, follows by a syllogistic necessity from the doctrine of election. Others conceive that the Antinomian heresy directly follows from the doctrine of reprobation; and * * that licentiousness and cruelty of the worst description are likely to be the fruits * * of Antinomian opinions. * * * Yet it would be rather a strong measure to hang all the Calvinists, on the ground that if they were spared, they would infallibly commit all the atrocities of Matthias and Knipperdoling. * * *

We do not believe that every Englishman who was reconciled to the Catholic church would, as a necessary consequence have thought himself justified in deposing or assassinating Elizabeth. * * * We know through what loopholes the human mind contrives to escape when it wishes to avoid a disagreeable inference from an admitted proposition. We know how long the Jansenists contrived to believe the Pope infallible in matters of doctrine, and at the same time to believe doctrines which he pronounced to be heretical. Let it pass, however, that every Catholic in the kingdom thought that Elizabeth might be lawfully murdered. Still the old maxim, that what is the business of everybody is the business of nobody, is particularly likely to hold good in a case in which a cruel death is the almost inevitable consequence of making any attempt.

Of the ten thousand clergymen of the Church of England, there is scarcely one who would not say that a man who should leave his country and friends to preach the gospel among savages * * would deserve the warmest admiration. Yet we doubt whether ten of the ten thousand ever thought of going on such an expedition. Why should we suppose that conscientious motives, feeble as they are constantly found to be in a good cause, should be omnipotent for evil? Doubtless there was many a jolly Popish priest in the old manor houses of the northern counties who would have admitted in theory the deposing power of the Pope, but who would not have been ambitious to be stretched on the rack. * * *

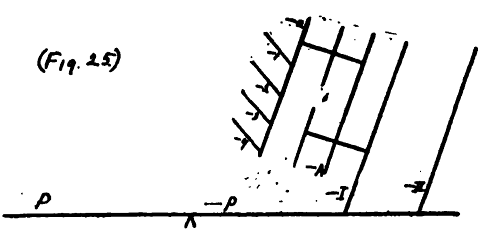
But the laws passed against the Puritans had not even the wretched excuse which we have been considering. In this case the cruelty was equal, the danger infinitely less. In fact the danger was created solely by the cruelty. * * * By no artifice of ingenuity can the stigma of persecution, the worst blemish of the English church, be effaced or patched over.

Analysis in detail. This is an example of refutation; the opposing argument stated and then overthrown. So far as the form of the selection is concerned, this is all that is done; but there is implied throughout, and stated in one short paragraph which apparently belongs to the refutation, a direct argument which serves effectively to establish Macaulay's own side, which we will call the affirmative.

The first paragraph states the argument which he proposes to answer. In brief, it may be given this form, minus signs being prefixed to the numerals to show that the argument belongs to the negative.

—P. The measures of Elizabeth were dictated, not by the spirit of persecution, but by political necessity.
  —I. In the case of the Catholics.
    —A. The Catholics were likely to commit treason.
      —a, To obey the Pope was to commit treason.
        —1. He annulled the Queen's title.
        —2. He attempted to depose her.
        —3. He incited rebellion against her.
        —4. He incited to taking her life.
  —II. In the case of the Puritans.

A diagram of this argument is given in Fig. 25. We may say that by agreement, the proposition is resolved into two opposing alternatives, Macaulay defending one and the negative the other. These two alternatives may, therefore, be denoted by P and —P respectively.



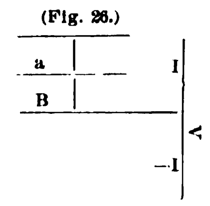
—I and —II may be regarded as two examples in support of —P. —II is merely an assertion, so far as here stated. The chain of reasoning in support of —I may be thus given:

—a. To obey the Pope was to commit treason. (Supported by the four points given, a posteriori.)
—a_o. The Catholics were likely to obey the Pope.
—A. The Catholics were likely to commit treason.
—A_o. Laws to punish those likely to commit treason (or those whose acts show that they hold doctrines presumably tending to the crime of treason) are a political necessity.

Before answering this argument Macaulay proceeds to examine three of the particular laws for which this defense is offered. Of the first of these he says in substance—

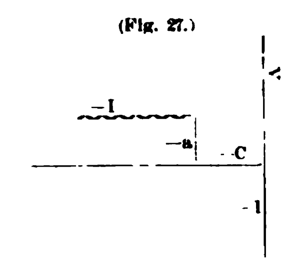
B. The law prohibiting the celebration of Romish rites was not a political necessity.
  a. It was passed before any hostility had been shown.

This may be regarded as an example, supported by a syllogism, and employed to prove the contrary of —I. The implied major is in effect this:



a_o. Laws passed to punish the hostile before they show hostility are not politically necessary. (Fig. 26.)

Concerning the second law, the argument may be stated in the same form.



(Fig. 27.)

C. The law punishing a refusal to take the oath of supremacy as high treason was not a political necessity.

a. It was based purely on suspicion.

This like B may be regarded as an example, resting on a syllogism, to prove directly the contrary of —I; and in that case its diagram will be exactly like that of B. It may also be analyzed (see Fig. 27) as the refutation of an implied —C which the negative is supposed to have used in defense of —I. In that case, the refutation consists in pointing out a fallacy of process. The cause of the passing of the law was disaffection, and the cause of the disaffection was said to be treasonable intent; but in point of fact that cause was the harsh laws already passed. This is the fallacy non causa pro causa. However, this analysis makes the argument less effective as an attack upon —I, and apparently less effective than it was intended to be in the original. The first analysis is therefore preferred, with diagram like that of Fig. 26.

The third law might be treated in the same way; but as it is more evidently than either of the others a direct inference from the implied major premise, —A_0, already stated, because the law immediately followed a Papal bull against the Queen, it is attacked by a more elaborate method. The implied reasoning upon which it is based is this:

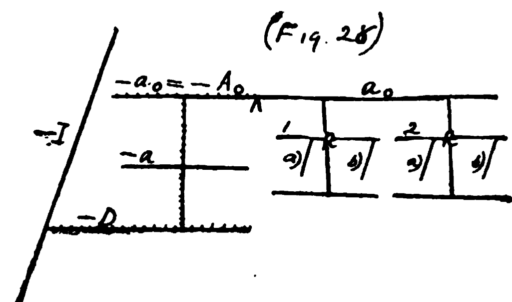
—a_0 (——A_0). Laws to punish those whose acts show that they hold doctrines presumably tending to the crime of treason, are a political necessity.

—a. The law inflicting the death penalty upon both parties, if a Catholic should convert a Protestant, was such a law.

—D. That law was a political necessity.

This conclusion bears to —I an inductive relation, as an example, and may be so represented in diagram. It is, however, attacked through the major premise, and this is really an attack upon the —A argument first stated. From this major premise are drawn two absurd conclusions. First minor, 1; such acts took place under Queen Mary: examples, a), the insurrection in favor of Lady Jane Grey, which took place before any provocation had been

given (a fortiori); and, b), the insurrection of Wyatt. Absurd conclusion; such a law against Protestants was a political necessity under Mary. Second minor, 2; every

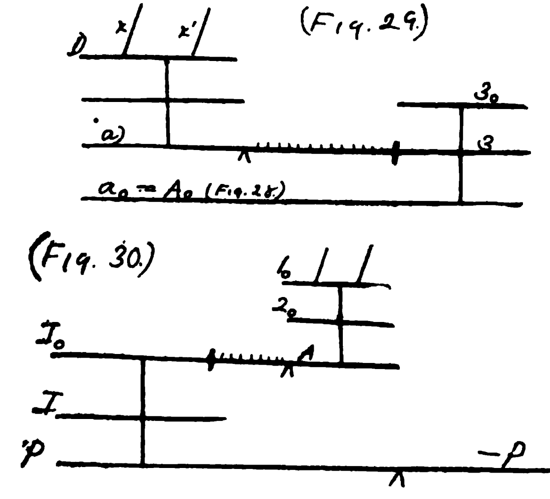


act for which religious persecution is inflicted may be looked upon as such an act; examples, a), Cæsar's persecution of the Christians; b), the massacre of St. Bartholomew. Therefore religious persecution is politically necessary; or there is no such thing as religious persecution. Diagram, Fig. 28.

As the diagram shows, this argument is ample to overthrow the attacked premise. Yet the next paragraph of the selection apparently continues the attack. Analyzed accordingly, the argument may be thus stated:

> 3_o. Acts of persecution are not required by political necessity.
>
> 3. Such laws (as those defined in —A_o) are acts of persecution.
>
> a). Such punishment as they inflict is not justifiable.
>
> 1). Justifiable punishment is punishment inflicted for crime actually committed.
> Examples (x, x'), Ballard and Babington.

A diagram of this reasoning, with a denial of —A_o as its conclusion, is given in Fig. 29. But besides the fact that additional argument is not needed here, it is apparent that in 3 we have used as a premise the principal conclusion of the entire discussion, that Elizabeth was



a persecutor. But as the premise is proved, this is not begging the question; but it is rather concealing in the middle of the dis-

cussion an important argument that we should have expected to find at the end of both brief and discussion. Restated to show its real force, this argument is,—

P. Elizabeth was a persecutor.
  I. She punished people for acts indicating that they held doctrines presumably tending to the crime of treason.
    A. Such punishment is unjustifiable.

The corresponding diagram is given in Fig. 30, and the argument fully syllogized is this:

1_o. Justifiable punishment is punishment of crime actually committed.
2_o. The punishment (specified in I) was not such.
A. It was not justifiable. (Alternative, it was persecution.)
  I_o. To punish (for acts specified in I) is persecution (since the alternative is not true).
  I. Elizabeth punished people for acts indicating that they held doctrines presumably tending to the crime of treason. (Admitted throughout.)
  P. Elizabeth was a persecutor.

The importance of having this argument on the affirmative side of the main proposition will appear when the analysis is completed. In summary of this part of the discussion, we may say that in ostensibly setting out to prove that the third law mentioned was not a political necessity,—which would merely have invalidated an argument from example, and have been comparatively a small matter,—Macaulay has also overthrown an important major premise in the first chain of reasoning (—A_o, restated as —a_o), and has at the same time introduced his only direct argument in support of P.

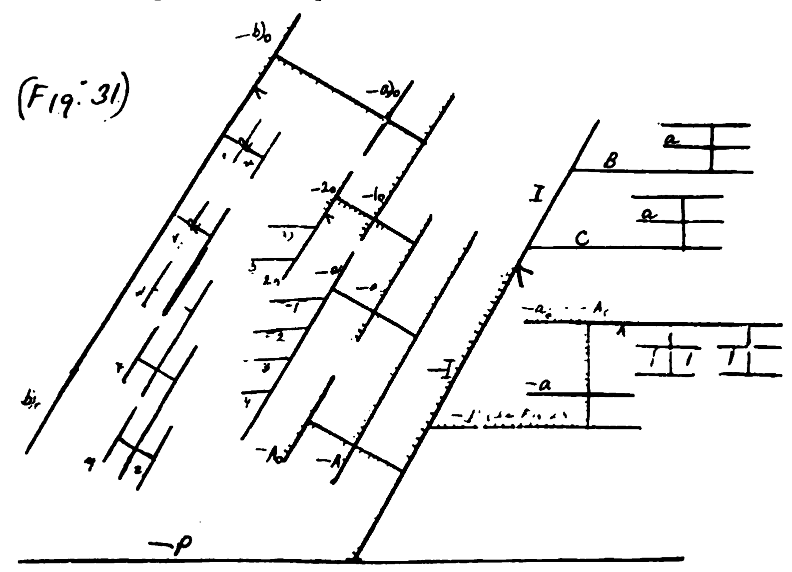
He next proceeds to pay his respects to the minor premise —A of the original chain of reasoning, and shows that so much of that reasoning as has been given by the negative is but the last of a chain, which, when fully expressed, shows "two enormous gaps." Each of these gaps, as it proves, is another fallacious major premise.

Two additional syllogisms are necessary to show the implied argument in full. These are:

—$b)_o$. What men ought by logical inference to believe they do believe.
—$a)_o$. Catholics by logical inference ought to believe it right to obey the Pope.

—1_o. Catholics do believe it right to obey the Pope
  —2_o. What men believe it right to do, they are likely to do.
  —1_o. (As before.)
  —a_o. Catholics are likely to obey the Pope.

Then follow the two syllogisms already given (—a —A, p. 41). The reasoning as now completed may be traced in Fig. 31.



Each of the two new major premises is attacked in turn. From the first, —b)$_O$, two conclusions are drawn by reductio ad absurdum; one of them derived from a chain of four syllogisms ludicrously like the chain of the negative. The expressed and implied propositions used in this chain are, lettered for convenience,—

—b)$_O$. (As given.)
v. Believers in election (Calvinists) ought by logical inference to believe in reprobation.
w. Believers in reprobation ought to be Antinomians.
x. Antinomians are likely to commit crimes deserving of capital punishment.
y. Those who commit such crimes should be hung.
z. Therefore Calvinists should be hung.

The second absurd conclusion is thus drawn:

—b)$_O$. (As given.)
t. The Jansenists ought to hold with the Pope in all doctrine (since they hold his infallibility).
u. The Jansenists do hold with the Pope in all doctrine.

The second new major premise, —2$_O$, is attacked by proving its contradictory: What men believe it right to do, they are not necessarily likely to do. Two examples are adduced in support: a), English clergymen who believe in missionary effort; and, b), English priests who, perhaps, believe it right to depose the Queen, but

are more unlikely to act (a fortiori) because in their case the consequences would be the more unpleasant. Each of these examples may at pleasure be stated as a reductio ad absurdum.

Fig. 31 shows this refutation in full. Everything leading up to —A is refuted, $—A_o$ is refuted in attacking —D, —D has been invalidated. All the support has been taken away from —I, and in addition B and C have been introduced to prove its contradictory.

There remains —II, but this is merely an assertion, and is disposed of with the single a fortiori argument that if laws against the Catholics were not politically necessary, still less so were the laws against the Puritans.

This leaves nothing of the original structure upon —P (Fig. 25). Yet the question might be still undetermined if there were no direct argument in support of P. Such an argument, however, has been found, and when given its place upon P as represented in Fig. 30, there is no longer any doubt as to the result of the discussion. By combining the several diagrams given, a complete map of the discussion will be made, and a map no more complicated than the discussion itself.

We may now construct a theoretical brief of Macaulay's entire argument, omitting some of the subordinate propositions.

Brief of selection.

P. The measures of Queen Elizabeth were dictated, not by political necessity, but by the spirit of persecution.

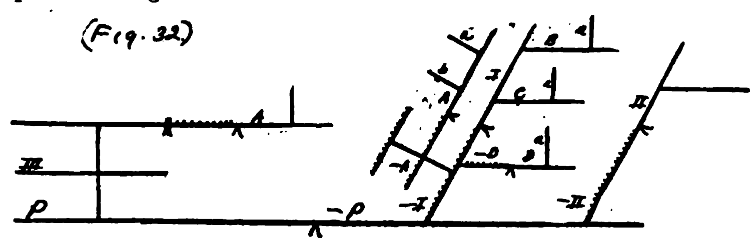
- I. In the case of the Catholics.
  - A. The Catholics were not necessarily likely to commit treason.
    - a. Men do not follow their beliefs to their logical conclusions.
    - b. Men are not always likely to do what they believe it right to do.
  - B. The law prohibiting the celebration of Romish rites was not politically necessary.
    - a. It was passed before hostility had been shown.
  - C. The law touching the oath of supremacy was unnecessary.
    - a. It was based purely on suspicion.
  - D. The law touching the conversion of a Protestant to Catholicism was unnecessary.
    - a. It punished not crime, but the holding of doctrines presumably tending to crime.
- II. Still more in the case of the Puritans.

If it were allowable to arrange the brief in an order materially different from that of the discussion,* we might add—

- III. Elizabeth put people to death for holding opinions presumably tending to crime.
  - A. As this was unjustifiable, it was persecution.

*It will be noted that in the amplification the treatment of A follows that of B, C and D.

After one has learned to make a correct brief in either analysis or original work, there may be no further occasion for diagrams; but they are often convenient for picturing the general nature of logical process, even where detailed analysis is unnecessary. For this purpose they may be simplified as a brief is simplified, by omitting subordinate lines, and by substituting the one line indicating inductive process for the four representing a syllogism, where the difference is not essential*. Thus simplified, a diagram corresponding to the preceding brief is given in Fig. 32. When diagram and brief are completed, they should, of course, be lettered to correspond throughout.



Further possible use of system. Diagrams may also be used as a sort of shorthand, in making preliminary analyses to be verified or modified later. For example, in beginning the analysis of the Macaulay argument, the following notes were made, the lines in the margin constituting an inverted diagram:

The laws against Catholics were a political necessity.

  The Catholics were traitors.

  Laws against traitors were a political necessity.

The Pope was a traitor

  He annulled Elizabeth's title

  Who annuls title of sovereign is a traitor

  As the Pope, so all Catholics

The Pope gave away Elizabeth's throne

Who gives away sovereign's throne is a traitor

  Catholics were bound in conscience to be traitors.

  Who is bound in conscience to be a traitor will be.

This is not as it stands in the final diagram, but the hints as to

*The difference may still be indicated by inclining at an oblique angle the line which stands for an inductive process, while drawing lines designating deductive processes at right angles, as in Fig. 32.

logical structure make revision and restatement much easier. By using dotted lines to connect the propositions with the marginal lines, either inductive or deductive processes may be roughly but conveniently recorded.

There may, of course, in logic as well as in mathematics, be more than one correct solution of a problem. Several analyses of the same discussion may differ considerably in details; but unless the composition analyzed is lacking in clearness or is defective in its arrangement, the analyses should be in substantial agreement as to its main outline.

Lack of space prevents further detailed illustration in this paper of the possible uses of this system. There remain to be explained its applications to various combinations of exposition and argument, and to the recording of a debate. Concerning these a few general statements may be made.

When definition appears in argument, it may sometimes be disregarded in the brief and the diagram; at other times, when of special importance, it may appear as a step in the reasoning taken by means of propositions of equivalence, represented in the diagram by additional syllogisms. When exposition precedes or follows the argument proper, it will, of course, have its place in the outline as introduction or conclusion, but will require no diagram.*

In debate. Of great interest to the student of dialectics is the analysis of debate. The effort has been made by means of the system herein explained so to record a debate that at its close the logical result might be evident independently of a vote by a committee of judges; and that, to some extent at least, logical certainty might be substituted for personal opinion.

In making record of a debate actually in progress, it was necessary so to adapt the system of brief-numerals that in rapid note-taking the office of an argument might be shown by a numeral as the argument was written down, before it was assigned its place in either diagram or brief. With this object in view, the first half of the alphabet and the numerals before twenty were assigned to the affirmative, the rest of the alphabet and the numerals after twenty to the negative. Minus signs were used throughout to designate negative arguments. Consecutive numerals were used on both sides, according to the first method illustrated in Fig. 2, page 8.

*The words *introduction*, *discussion*, *conclusion*, should never be made an actual part of a plan or brief. So to use them is to evade the labor required to determine and phrase the central thought of the introduction, discussion, or conclusion, as the case may be. They may have a place in the margin, or in parenthesis, but not as headings in the outline.

The refutation of an argument was designated by repeating the numeral of that argument and changing its sign. For example, —B denoted the refutation by the negative of B, an affirmative argument; but R denoted the refutation by the affirmative of —R, a negative argument; the letters themselves showing by which side the argument was introduced. In case an argument was by either side inadvertently repeated, the repeated argument was designated by the numeral already assigned to it, the numeral being primed to indicate the repetition, In making a diagram from these notes, no modification of the system of diagrams was found necessary.

While inconclusive, the result of the experiments hitherto made indicates that in a debate clearly presented, and as closely analyzed as is possible by this method, the element of personal judgment may have less weight in determining the decision than is usually the case, and may sometimes even disappear. But while to determine the result of a debate by a blackboard demonstration may sometimes be fairly practicable, to eliminate the personal element entirely is, of course, notwithstanding the view taken in a recently published work,* impossible, until logic, like mathematics, shall base all its processes upon axioms and universally accepted definitions, until men shall cease to disagree as to the meaning of terms, and until there shall be some absolute standard by which the relative weight of opposing arguments may be definitely ascertained.

Conclusion. In conclusion, it is evident, as was stated at the beginning, that what is of importance is the close analysis and not the method of making it. But a very little practice in making such analyses will show that by far the greater number of writers lack a clearness that might easily be secured in this way;** that they do so is undoubtedly, as experience with classes shows, because the process of analyzing is so often complicated and difficult; and if this paper aids in making the process easier, or if it suggests how it may be made easier, it will have accomplished its purpose.

*Hawley; Infallible Logic.
**See Bates; Talks on Writing English, chapter X.

Dialect Word-List.—No. 3.

BY W. H. CARRUTH.

The words reported have all been heard in Kansas; only when known is another source reported. The writer will be glad to receive comment, confirmation, or addition.

airth, s.: earth.

back-number, s.: anything out of date or antiquated, as of a stale story or a conservative person=''has-been.''

banter: to try to arouse to a trade.

banter, s.: a ''stump.''

beef, to: to find fault with anything, having only inadequate cause.

beezlums: cake from first milk of fresh cow,—Dickinson Co. Comp. *beestings*, first milk from fresh cow.—Cent. Dict.

belly-ache around,: to plead whiningly for something.

big church, s.: no church, as, ''He belongs to the big church.'' S. Ks.

blind tiger, s.: Prohibition State saloon, where one gets his drink but does not see who gives it to him.

boggle at: to stumble over, to botch. (Stead, in Review of Reviews, March, 1893.)

budge, s.: strong drink; as, ''He's fullof budge.''

buttons: onion-sets, (Arkansas).

cagy, adj.: keen, or full of animal spirits.

carry: to escort; as, ''May I carry you to the singing school?''

catch it: to receive a scolding or a whipping; as, He caught it for going in swimming.

craw-fish, v.: to back out, or show a disposition to do so.

cornish, s.: for cornice (very common).

cave around: to bluster, as when in violent anger.

check: ''chuck'' lunch:—Chester Co, Pa. Cent. Dict. has the word as meaning portion or share; cp. chuck=steak.

cheese it!: cease, desist.

chink, s: money.

choose up: method of deciding which leader in a game shall have first choice of players.

choosing-note: grace-note.--Ohio.

chore (char): a bore; as, Life's a chore,=burden.- E. S. Martin, et al.

comb : ridge-pole.—Tennessee, N. Indiana.

come down, v: to cease pretence; as, O, come down! i. e., you don't mean it!

come-down-shun: a humiliation; as, It was a great come-down-shun for him.

crimp: same as 'tuck,' in 'to take the crimp out of one.'

dauncy: indisposed. Pa.

deadening: wood-lot of girdled trees.—W. D. Howells in 'Recollections.' Bartlett.

dip: a blow; as, Hit him a dip.

diff: " " " " " diff. cp. 'lick', 'clip', 'whack', all used similarly.

dirt, s.: in 'to do dirt,'=to work underhandedly against.

dog: style; as, 'sling on dog,' i. e., put on style.

Dornics or **Donics**: a game with small stones, also the stones themselves;—N. Y. and Mich.—equivalent to 'duck-off', 'duck-on-a-rock.' Bartlett has donock, but not the game.

doofunny: a thing not easily described, or thus mentioned to save description; cp. thingumbob, thingumajig, thingumagummer. fum-a-diddle.

do up: to beat; to cheat.

drean, v. and s.: drain.

ear: as, He is on his ear (angry), or, he walked off on his ear.

eye: thing, in 'that's the eye,'=the proper thing (probably from base-ball).

Easter-bells: Easter-lilies, March lilies, Granmammy's night-caps, Dog-tooth-violets; Kansas; Brandywine lily; Adder Tongue, (Ohio). (Erythronium albidum).

faded: "fixed", intimidated; as, 'We've got him faded'=He's harmless. Comp. O. E. fay, German gefeit.

fip, s.: a trifle, from fipenny bit(?)

fiddle: to idle, as to fiddle away one's time; to fiddle around.

fiz. s.: hurry; as, Don't be in a fiz.

fizzle: to "Peter out." Cent. Dict. gives the meaning *fail*; better the quotation in Bartlett from Williams' College, as comp. to flunk.

fizzle-dust: something infinitesimal; 'fine as fizzle-dust,' cp. frog-hair.

foasty: mannish, buckish.—Arkansas.

forty-eleventh: very distant; as a forty-eleventh cousin. cp. forty-second, steenth.

frog-hair: something infinitesimal, as, 'fine as frog-hair.'—S. Carolina.

fum-a-diddle: see doofunny.

get: to puzzle; as, That gets me.

get a { move / wiggle / action } : to hurry; as, Get a move on you(rself) there; one of the few reflexive uses of simple pronouns in modern Eng.

get down: to understand; as, I've got that down fine; i. e., I've mastered it.

get it: be whipped or receive a scolding; as, Won't you get it though when you go home!

go to grass: go along! (Expression of impatience and incredulity or the like).

grinstone: grindstone. Kansas. Cent. Dict. gives the form green-stone, a very fine-grained stone for putting a keen edge on razors, surgical instruments, etc.

grumps: noun from the adj. *grumpy*; as, 'He is in the grumps,' 'to get the grumps.'

hack-work: work done without love, merely for bread.

half: an intensive word, in such expressions as, a 'man and a half,' etc.

havers:='shucks'—in 'to go havers with one', to share with.

ham: telegraph operator (R. R. slang).

hand-me-down: machine, or store-made (clothes): hence ill-fitting.

hang up: to put up over night; also, to defer indefinitely, as by referring to an inappropriate committee, (legislative).

bad egg / **hard egg** } : a 'tough' character.

heat-a-piece: an untilled corner between fields, N. E., N. Y. heater-piece. Bartlett.

heeled: guarded, supplied with wealth.

high lonesome: a 'glorious' drunk or spree; as, He goes off on a high lonesome occasionally.

hob: destruction, in the expression, You've played hob with that machine. Comp. play thunder, play Ned.

ho-bo } : in K. C. ordinance, a tramp who 'beats' his
haut-beau? } railroad fare. , a "night-man"—(sewer-cleaner) —Bartlett.

hog, v.: hog it, to play the the hog.

hog-hole, s.: a means of evasion, or escape.

hog-wash, s.: nonsense, sentimental palaver.

hole: (Germ. Wetterloch); as, "The wind is from the north hole today." That and the N. W. hole are the coldest holes we have." (Cent. Kansas.)

hoodoo, v.: to deceive or cheat in a blustering manner; to deceive by witchcraft, or unusual means.

hoot, n.: a peep; as, I have taken a hoot at Harper's Weekly. N. E.

in it: having an important part; as, We're strictly in it; successful condition.

jab: to thrust, to stab. Jab is the regular word in my dialect; *iob*, given by Webster, was always regarded as colloquial. Bartlett.

jack: stove-lid. Indiana.

jack-me-up: 'poke' me up, give me a reminder.

jar, v.: to surprise or shock; as, "Doesn't that jar you?"

jaw, v. tr. and intr.: to scold, to quarrel in words.

jaw, s.: abuse; "Don't give me your jaw."

jiner, s.: one who joins many associations, enterprises, etc., especially one who joins the church.

job, s.: a trick, a conspiracy; as, They are putting up a job on you; i. e. planning a trick against you.

jobbery, s.: indulgence in 'jobs.'

jog: to stir up; as, 'Jog his memory.'

josh: to "gag," to tease with quips and jests.

josh, s.: in, for josh=for fun.

joshing around: floundering in language.

jumper, s.: cp. 'ho-bo', a tramp who 'beats' his railroad fare.—Charities Review, 1894.

Jumping Jesus: a lame man. Among street-boys. Also Limping Jesus.

kicker, s.: an objector, fault-finder; as, He's a chronic kicker.

knock: to secure; as, He's knocked the prize.

knock-down, s.: an introduction.

knock-down, adj.: conclusive; as, a knock-down argument.

knuckle-down, v. intr.: to be subordinate, to 'play 2nd fiddle.' In the Cent. Dict. yield, or submit in contest.

land-louper, s.: a tramp. Used in Civil War. Comp. Land-lubber; Germ. Land-läufer.

lapjack, s.: to play lapjack=to switch.

lamm: to whip; as, Lamm it to him. Also without "it to." Bartlett.

Laros to ketch meddlers: cp. Larofameddler, (from lay-over =bear trap, for meddlers). Miss Murfree's "In the Clouds," p. 406.

left, over the: not serious. It is a children's trick to make an improbable assertion to attract attention, and then to save themselves by adding, 'over the left,' or, 'over the left shoulder.' (B.)

let up, v. intr.: to cease, in, Let up on him, =cease talking about him; let up on that, cease doing that. Bartlett has trans.

let up: cessation; as, without any let up. B.

make, s.: desire for profit; as, I'm on the make.

meaner'n: in Meaner'n a rail, or, meaner'n a mud fence stake and ridered with bull-frogs.—Ind.; Gar-broth thickened with tadpoles. —Old lady from N. E., Scotch descent.

manuprint: type-writer work.

middle-of-the-road, adj.: uncompromising, as, a middle-of-the-road populist.

motorneer: manager of the electric motor on street cars.—Topeka Capital. Octave Thanet.

Ned: a scolding; as, "She gave him Ned, (or, the very Ned, or, particular Ned)"; also, a disturbance, as, 'to raise Ned.'

onto, adj.: awake to; also, 'up to.'

onliest: only, or best. It's the onliest hat I've got.—La.

original: one-testicled stallion. Gen'l in country. Cent. D. gives the forms ridgeling and ridgel as applying to any other animal, as well as the horse.

out of sight: superior, as, This actor is out of sight.

peanut-butcher: a train-boy.

pick / **pick onto**: to tease, nag, or hector.

pick-up, n. and adj.: stray.

pick-up, v.: to find in error, I picked him up on that.

pike bum: a country tramp.—in Charities Review, 1894.

plutocrat: opposition name for members of the Republican or Democratic parties, in reference to their alleged undue regard for wealth.

pomalo: a fruit something like the grape-fruit, or like the citron. Called also 'Shattuck' after the introducer.—S. Cal.

populism: the doctrine of the 'People's Party.'

pucker: "Works like a charm and no pucker." Chetopa, Kans. '94. Cent. Dict. has *pucker* as meaning confusion.

pult: a young turkey.—Kansas. Common in N. of England= pullet?

put up for: to make a deposit as security, or to pay for; as, We put up for the team.

Quaker-flip: a kiss. Ohio.

rantankerous: noisy, lawless.

razzle-dazzle, s: a 'fake'.

rasp: to surprise, and to irritate.

rainch: rinse, rense.

rigged: plagued, teased, hoaxed; as, "They played a practical joke on the old man and he was terribly rigged about it"—Cent. Dict. has "run a rig," meaning to play a joke.

risin': swelling in the head.

rizzle: to 'loaf' around in the sun. Linn, Mass.

roast, n. and v.: to give an unfavorable criticism of a person: as, a newspaper roast.

run: in, on the run, =scared, retreating, as We've got'em on the run.

run around: to 'cut out.'

run a sandy: to 'bluff' (poker term.)

rush: to let grow (of the beard).—Shelbourne, Mass.

rush, v. tr.: to solicit for a secret society.

sack v. tr.: to 'give the mitten,' to jilt, S. Kans.

say-so, s.: wish, decision; as, If I had my say-so; i. e., if I had my way about it.

scads: large quantity; as, He has scads of money; also money, If I only had the scads.

scaly: questionable.

scashs, scatch: to hide.—Missouri. (French *cache*?)

scooch, **scoot**: to hasten, run.

scoop, s.: a victory (in getting earlier news), (newspaper slang); also verb tr.

scrooch, v. intr.: to crouch down, to slink.

seasoning, **qualifying**, **dressing**, **trimming**: sugar and cream in coffee.

send-off, s.: a start or assistance of some kind.

seed, s.: in "old seed,"="back-number"—comp. seedy (adj.)

shacks, n.: brakeman (R. R. slang.)

shirt: in, Keep your shirt on;=keep calm.

shirt, to tear one's: to exert oneself, or to do remarkably well at recitations. Used at West Point.

shoot a snipe: to pick up a thrown-away cigar stump.

shooting-match: (with whole), total, as, to go through the whole shooting-match; i. e., the whole of it.

shot: amount, or distance. in, "not by along shot." Comp. not by a long sight; not by a dem sight; not by a jug-full.

shovel bum: a city tramp.—in Charities' Review. 1894.

show, v. tr.: punish; as, I'll show you. Comp. *teach* and *learn* used in the same way.

show down, s.: to make a:=to make a showing.

shucks: 'havers', as 'to go shucks with one.'

shut her off: "ring off," cease.

shy: 'out' or short; as, I'm shy a pair of rubbers. (Poker term.)

skift: a small quantity; as, a small skift of snow; i. e., a light snow. Used only in this connection.

skun, pret. and p. p. of skin: 'skinned,' especially in the game of 'keeps'.

skunk: to 'stump', as, I'll skunk you to do etc., also to 'whitewash' in a game.

slues: a large quantity. Cent. Dic has slue, with the same meaning. Comp. slathers, and v. slather,=to throw about loosely.

slush around, v.: 'josh around,' to go knocking about.

smile, v: affirm, in I should smile=yes, indeed; cp. snicker.

smile, s.: a drink of liquor.

smoke: to shoot. (Magazine of Short Stories.)

smooth adj.: 'slick,' plausible; also admirable.

snappy: flashing, as, snappy eyes.

snoopy: like a 'snoop.' B. has verb, to eat clandestinely.

sooner, s.: an unscrupulous person.

sooner, s.: a "boomer" (see List 2) who anticipates his privileges and enters upon land before it is opened to settlement; arose in the settlement of Oklahoma.

spludge, s. to make a: to make a splurge.

spool-pig, s.: weakling.

starch, s: energy, spirit; as, It takes the starch out of him.

sticker: a paper slip, with printed name, gummed for attaching to ballots. *Paster* is given in the Cent. Dict.

stomp: to stamp, with especial reference to the sound. Comp. tromp: tramp.

stove up, v. tr.: to make stiff; as, Such driving will stove up your horse, or, the horse is all stove up.

stuff, s.: right thing, proper thing, or, thing desired; as, That's the stuff.

stumps, in a hard row of: an unfortunate condition; as, We're in a hard row of stumps.

suck-hole: an eddy; and a fabulous hole in the bottom of a river, believed by boys and some men to go down to the center of the earth, and to suck swimmers in.

Sunday was a week ago: a week ago last Sunday.

step-off: a ledge under water.

swipe: to filch, to 'snake,' also to 'skunk.'

take in: to visit or go through; as, We took in the town.

taken: take. I taken it he is a stranger. S. W. Mo.; E. Ks.

thingumbob
thingamagummer
thingumdoodle } : see doofunny.

titman: suckling pig.—W. D. Howells, in Recollections.

touch, v. tr.: to steal, also, to cheat.

too gauzy
" **attenuated**
" **transparent**
" **skinny** } : too 'thin.'

trade-last: a compliment for which a compliment is expected in return. (Not trade-lasts).

tromp, v.: to tread heavily. Distinguished from 'tramp', to make a journey.

tuck, s.: energy. spirit; as, It took the tuck all out of me.

tunking about: 'knocking about'.

up-in-G: high-toned.

whack: time, game (chiefly in marbles), as, two a whack; every whack; comp. lick. Also, opportunity: as, Give me a whack at that pie.

whaley, to play: to play hob; to fail (in doing something.)

whooper: 'whopper', a monstrous thing; also iron., a great lie.

working, his head is: he is crazy (sportively). R. R. slang).

wrinkle, s.: device. 'A new wrinkle.'

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Productive Co-operation in England.

F. W. BLACKMAR.

A visitor at the Crystal Palace during the wonderful exhibition of the co-operative societies held August 18 to 22, 1896, must have been surprised at the extent and variety of the exhibit and impressed with the wonderful growth of co-operation in England. A careful inquiry into the history, methods and conditions of productive co-operation would further convince thevisitor of the success and permanence of the co-operative project, and did he associate for a time with the labor leaders of England he would observe that the labor problem is much further advanced there than in the United States. It has there reached the stage of reflection and reason. Its theory is positive and its practice constructive rather than destructive. Labor leaders are directing their organized efforts less against the employer and the capitalist and more toward building up co-operative business and securing representation in politics. Having entered this rationalistic state there is less passion and less aimless agitation than formerly. There is a growing feeling that it is economic conditions rather than a capitalistic class that laborers must cope with, hence the positive theory and practice in building up the interests of laborers.

It has been common for economists to remark concerning the success of distributive co-operation in England and its failure in the United States and to consider productive co operation outside of a few notable examples a failure in every country on account of the difficulties in its way. Until recently these statements were mere historic facts, but at last productive co-operation has established itself permantly in England and is daily achieving renewed success. Since 1870 an entirely new movement in this line was started which today is in a most flourishing condition.

The experiments in co-operation which were tried in England between 1820 and 1844 were nearly all failures, indeed, it may be said that no practical results appeared on account of the agitation of the subject at that particular time. Finally a few people at Rochdale discovered the secret of successful co-operation in the distribution of goods. They organized the famous society known as the Rochdale Pioneers, which began to carry on in a meagre way a co-operative store for the benefit of the members of the society. The Rochdale society grew from a small membership and an insignificant business with a small store into three large co-operative branches having in 1895, 19,064 members, a share and loan capital of £476,740 and an annual trade of £402,222 which yielded a profit in 1895 of £57,776. More than this, the movement that started in Rochdale spread throughout the entire country, until in 1895 there were 1,486 distributive societies having 1,314,093 members. The share, loan and reserve capital amounted to £16,474,630 and their trade amounted to £34,224,815 which yielded a net profit of £4,892,712.

The principles controling distributive co-operation are so well understood that there are few failures compared to the number of successes. Yet in other countries outside of England its success has not been so marked. Thus in the United States through the Grange and the Farmers' Alliance many co-operative stores were started nearly all of which proved failures. Wrecked institutions followed in the wake of these two great movements. The principles governing productive co-operation are not so well established, hence, there have been numerous failures in all countries where attempts to carry it on have been made. Its methods are so different from distributive co-operation that it requires greater skill in management to insure success. The production of a good quality of goods without loss or waste is not more essential than the obtaining a market for the goods after being finished. Even the Rochdale movement which started with the idea of productive co-operation was obliged to abandon it.

Numerous experiments have been tried in different countries with varying success, but it was not until 1870 that the movement received an impetus which brought it permanent success. Several productive societies were formed on a co-operative basis in which the wage-earners became their own managers and secured to themselves all of the surplus profits. These efforts were greatly forwarded in 1884 by the establishment of "The Labor Association," which had for its special work the promotion of co-operation among wage-earners. The importance of this association is sufficient reason for

setting forth in detail its objects as given by Mr. E. V. Neale, its first president and founder.

"I. To form public opinion on the subject of associated labor by the following means, viz:

1. The publication and supply of literature.
2. The delivery of lectures, addresses, etc.
3. The holding of conferences of all classes of persons interested in the elevation of the worker.
4. To assist working men to organize themselves for mutual employment.
5. To enlist the active members of the trades societies in the co-operative movement.
6. To secure a united action of trade unionists and co-operators for mutual benefit and progress.
7. To give information generally on the position of co-operative workshops and condition of workers."

In order to carry out these principles and to obtain these objects, branches and lodges of the Association were formed each governed by rules and regulations best suited to the ends sought. "It will be seen," says Mr. Neale, "that the Labour Association is essentially a propagandist body, which seeks to form opinion, and thus to stimulate action, and, if it succeeds in calling forth productive societies, may serve as a valuable union among them; but does not itself propose to engage in any productive enterprise, and therefore will not in any way pledge the responsibility of any persons who may want to join it, by any sort of commercial undertaking." By the means of this strong agency the cause of co-operation is kept before the people interested and its gospel perpetually preached.

Among the forty societies that had exhibits at the Crystal Palace referred to above, the following industries were represented: Agricultural and Horticultural; Worsteds; Manufacture of Needles; Bookbinding; Boots and Shoes; Pianofortes; Nails; Pottery; Cotton Goods; Tannery; Watches; Buckets and Fenders; Quilts; Engineer's Goods; Household Goods; Ironworks; Clothing; Hosiery; Printing; Cocoa; Leathergoods; Ship and Boat-building; Padlocks; Woolen and Cotton Goods; Sundries; Silks; and Woolens. Thus it is seen that the co-operative societies cover a wide range of industries and are capable of engaging in almost any enterprise. The progress of most of these associations is very slow and yet the permanent and business characteristics are evident. Take as an example the Hebden Bridge Fustian Manufacturing Co-operative Society, Limited, which was organized in 1870 for the purpose of manufacturing fustians, velveteens, cords and and moles of all kinds. Hebden Bridge had long been the center for the manufacture of fustians. But the

trade had for some time been disturbed and the relations between employers and employees had been strained. There was much suffering among the work people. When one of their number, an old man, died on account of carrying too heavy a burden, it was necessary to raise funds by subscription to give him a decent burial. This was the occasion of forming a friendly society to provide for cases of this kind. They fixed the assessment at three pence per week and agreed that the funds should be devoted to the establishment of a fustian cutting and dyeing establishment. About thirty, all poor men, formed the original company. Their subscriptions were at first very meagre but they continued to lay aside their earnings. When they accumulated £10, it was invested in a co-operative store in town. It was estimated that it would take £1,000 to purchase a dyeing establishment and rent a place to carry on the work. They rented a small room and used their spare time to fit it up, and to put in a few fixtures. By vigorous work they found at the end of the first quarter they had a capital of £37, 7s, and 11d, with which to begin work. The members did the work at the usual rate of payment and this added to their share capital. The local stores became their customers and their market enlarged to adjoining towns. The society soon had sixty members and they began to manufacture ready-made garments as well as cloth. In 1874, they extended their business and opened a dyeing shop, and in 1886 they enlarged their plant and began to weave their own fustians. The constant progress of the society is best illustrated by the following table:

		CAPITAL.				
Year.	Members.	Share.	Loan.	Reserve.	Sales.	Profits
1870	95	£ 83	£ 3		£ 55	£ 3
1880	384	15693	3065	£ 556	18625	1774
1890	684	21764	9081	1595	38794	3499
1891	732	22399	3979	1427	40178	3723
1892	742	23749	9840	1937	39578	5118
1893	746	24497	8652	2610	39991	4427
1894	769	24904	8770	2890	40317	4171
1895	797	25845	6771	3859	43569	5185

At first all profits accruing to workers are accredited to share account until they have each £20 of stock in the association. In 1894 the results of business were as follows: The total amount paid to workers as wages was £12,851, and the amount of profit to workers was £642 computed on the basis of one shilling in the pound

for wages paid. The average number of workers during the year was 294. Of the 797 members on the books at the close of 1895, 297 were workers, 300 were co-operative societies and 200 were outside share holders. The capital stock was held as follows: workers £7,398; co-operative societies £10,415; outside share holders £8,032.

Nearly all of the co-operative societies divide their profits among purchasers according to the amount of the purchase. A certain per cent is given to capital, a certain wage and profits to labor, and a certain per cent to customers. More than this, certain amounts are set aside for education, insurance, care of the sick, etc. Thus in 1895 the society described above devoted £60 to education. It was one of the oldest societies formed. Among the modern societies much more attention is paid to education and miscellaneous expenditures. Many of the manufacturing co-operative societies have stores of their own or else make sales in connection with other co-operative stores. Thus the Kettering Co-operative Boot and Shoe Manufacturing Society was established in Kettering where there was a co-operative store of 3,070 members in 1894, having annual trade of £57,613. The manufacturing society after providing for interest on capital and depreciation divided the gross profits as follows: 40 per cent to workers divided pro rata on wages paid; 40 per cent to customers divided pro rata on purchases; 5 per cent to managing committee; 5 per cent to provident fund; 2½ per cent to educational purposes and 7½ per cent to capital reserve. The society is managed by a committee of twelve chosen by the share holders. Each member is required to hold five shares and may not hold more than twenty-five. After reaching that amount any further addition he makes to this investment is credited to loan account to the extent of £25, receiving five per cent per annum and not sharing in the bonus on transferable shares. The business of this establishment has grown since 1889 from £3,588 to £26,255, in 1895.

The growth of the entire co-operative enterprise is best illustrated by the following table:

	1883	1893	1894	1895
Number of societies,	15	109	120	155
Sales for the year,	£ 160,751	£ 1,292,550	£ 1,371,424	£ 1,859,876
Capital: share, loan, reserve,	103,436	639,884	799,460	915,302
Profits,	9,031	67,663	68,987	94,305
Losses,	114	2,984	3,135	2,296
Net Profit,	8,917	64,679	65,852	92,109
Profit to Labor,		8,283	8,751	14,235

The object of the co-operative society is to interest the laborer

directly in his work; to encourage him in the hope of reaping the share of the profits over and above the fixed charges and to make him an independent business man who shall have a right to determine the direction of his own labor power. As soon as his interest in the business is established he takes stock and becomes a shareholder and thus receives a right to vote in the management of the affairs of the society. He now becomes careful of tools and material, is saving of time and prevents waste; and he seeks to make a genuine, finished product. There is no need of strikes and lockouts, the war between capital and labor is over because the capitalist and laborer are the same. Their common interests have been demonstrated.

Whenever productive co-operation can be successfully carried on it has a good influence on society at large. Perhaps the labor problem can be solved in no other way except in giving the wage-earner a voice in shaping his own course, in managing his own business, in employing himself instead of being hired as a machine and thrust aside at the will of the employer. The idea of co-partnership in business is elevating in its very thought. But if productive co-operation should succeed until a large number of workers should be employed in co-operative enterprises these enterprises would begin to compete with each other and there would be competition by groups instead of by individuals. What then would happen to those who have not yet joined a co-operative association? They must of necessity suffer the results of grinding competition which harms not their more fortunate co-operative brethren. But the time may come when these also will be forced to become co-operative. The great difficulty is that it takes a long time to make good co-operative workers. It is a process of education—a slow process. And one of the chief reasons of the failure of co-operation in so many instances is that those who enter it are not co-operative men by nature and by training. Its success has finally been demonstrated in England and it helps toward the solution of the labor-problem, but its judgment is not final or conclusive.

Pronouns Used in Address in Lessing's Dramas.

BY W. H. CARRUTH AND EUGENE C. ALDER.

The psychological processes and social conditions which lead to the substitution successively of the second person plural for the second person singular, of the third singular for the second person singular, and of the third plural for the second person plural and singular, will be material for an interesting chapter, but that chapter cannot be written until the history of the phenomena has been written more carefully. Out of a large mass of miscellaneous collections in this line the German Department begins here to publish a record of these usages in the classic writers of the Eighteenth Century. It is hoped in time to bring together thus the materials for general conclusions. A careful examination of even a few authors shows that usage has not been as uniform and systematic as would be inferred from the statements of standard grammars and dictionaries and the scanty special publications on the subject.

To keep down the bulk of matter the method observed is to give page or line references only where variations and unexpected usages occur. Thus, if Minna uses Du regularly to Franziska, it is noted without definite reference, but if she uses Sie to Tellheim and then changes to Du, the references are given for the nearest conjunction of these forms.

Der Junge Gelehrte.

(January, 1748.)

SCENE: Germany; time, first half of 18th century; persons in mercantile life.

Damis (the Young Scholar, son of Chrysander),

to Anton (servant): Du. But, Sieht der Schlingel nicht dass ich lese? Will er mich länger stören? (May ignore Anton); next speech, Du guter Anton (I, 1).

Gelehrsamkeit (apostrophe): Du.

Betrogene Thoren, " : Ihr.

the Germans, " : Ihr.

Chrysander: Sie.

Lisette (servant): Sie (sing.) liebe Lisette! frequent and consistent.
Julianne (prospective betrothed): Sie.
Valer (old friend): Sie.

Anton (attendant of Chrysander and Damis),
to Damis: Sie.
Chrysander: Sie.
Lisette: Du (through many moods). But (III, 13, in imagined conversation), Will Sie mich, Jungfer Lisette? O Sie muss mich. Ich will Sie die Leute lehren unglücklich machen.
Lisette and Valer: Ihr.
Valer: Sie.

Chrysander (father of Damis, guardian of Julianne),
to Damis: Du. But (I, 2,) Bleib Er mir, Herr Informator, mit den Possen weg! Yet just after, Mensch, Mensch! Deine Mutter, etc.
and then, Den Augenblick schwur er, er kenne keine Frauenzimmer, etc. (no indication of this being an aside). Then (III, 4,) He, Herr Doctor, vergess Er nicht dass ich Vater bin! But next speeches, full of abuse, Du.
Lisette: Du.
Valer: Sie.
Anton: Du.
Julianne: Sie (sing.), Jungferchen!

Lisette,
to Chrysander: Sie.
Damis: Sie.
Julianne: Sie.
Valer: Sie.
Anton: Du.
(reports conversation between Chrysander and Damis, in which she preserves): Damis to Chrysander, Sie, Chrysander to Damis, Du.

Julianne,
to Chrysander: Sie.
Lisette: Du.
Valer (favored lover): Sie.
Damis: Sie.
(quotes lady to two knights in novel): Ihr.

Valer (old friend of Damis),
to Julianne: Sie.
Lisette: Du.
Anton: Sie.
Chrysander: Sie.
Damis: Sie (even in violent abuse).
Anton and Lisette: Ihr.

Die Alte Jungfer.

1748.

SCENE: Germany; time, contemporary; persons, middle class.

Oront (householder, matchmaker),
to Jungfer Ohldinn: Sie.
Frau Oront: Du.
v. Schlag: Sie.

Frau Oront,
to Oront: Du.
Ohldinn: Sie.

Ohldinn (the old maid),
to Oront: Sie.
Frau Oront: Sie.
Lisette (maid): Du.
Klitander (friend of her cousin): Sie.
Kräusel (poet): Sie.
Peter (disguised as Cap. v. Schlag): Sie.
Rehfuss (creditor of v. Schlag): Mein Freund, Er wird wohl thun wenn Er seine Forderungen ein andermal vorbringt.
v. Schlag (as stranger): Sie.

Lisette, Ohldinn's maid,
to Ohldinn: Sie.
Lelio (cousin of Ohldinn): Sie.
Peter (peddler): Du.
Klitander: Sie.
Poet and tailor: Ihr Leutchen; but next speech, Warten Sie doch.
Kräusel (poet): Du verdammter Hundsfott von einem Poeten; but next speech, Sie.
Peter (as v. Schlag): Sie (III, 6).
Peter (as v. Schlag, aside): Du (III, 6).
Peter (as v. Schlag, angry): Was will Er, mein Herr? (just after above).
Rehfuss: Nein, guter Freund, Er kömmt an die Falsche; also politely.
Peter: Du.

Lelio,
to Lisette: Du.
Peter: Du.
Klitander: Du.
Ohldinn: Sie.
Kräusel: Sie.
Peter (as v. Schlag): Sie.
Rehfuss: Er.
v. Schlag: Sie.

Peter 1 (cake peddler),
to Lelio and Lisette: Ihr Leutchen.
Lelio: Sie; but Ihr Herren (you and your like).
Lisette: Du.
Kräusel: Du.

Peter 2 (disguised as v. Schlag),
to Lelio: Sie.
Lisette: Klappermaul, Ihr.
Ohldinn (supposed betrothed): Sie.
Ohldinn: Wäre Sie schon meine Frau ich wollte Ihr das dumme Wort aus dem Maule bringen (III, 6,).
Ohldinn: Nicht wahr, meine liebe Frau, Du willst es bezahlen?
Ohldinn (dictating marriage terms): Versprechen Sie's?
Kräusel (acting as proprietor): Er.
Rehfuss: Mein Freund, wenn Ihr was zu sagen habt, so macht es kurz! But soon after, Lass' Er Sich um die Bezahlung nicht bang sein! Und Er, mein Freund, kann Sich Seiner Wege packen.

Klitander,
to Lelio: Du.
Lelio and Lisette: Ihr.
Lisette: Du.
Ohldinn: Sie.
v. Schlag (apostr.): Du.
v. Schlag: Du.

Kraeusel (poet),
to Ohldinn: Sie.
Lisette: Sie.
Peter (as v. Schlag): Sie.

Rehfuss (creditor of v. Schlag),
to Ohldinn: Sie.
Peter (as stranger) Sie.

v. Schlag,
to Ohldinn: Sie.
Peter (unmasked): Nichtswürdiger, Du.
Lelio: Sie.
Klitander: Du.

Tailor, to Ohldin: Sie.

Damon.

1748.

TIME: First half of 18th century; place, Germany: persons, merchants and other middle-class people.

Characters: The Widow; Leander and Damon, suitors and rivals, but apparent friends; Oronte, Damon's cousin; Lisette, The Widow's maid-servant.

The Widow,
to Lisette: Du.
Damon: Sie.
Leander: Sie.

Leander,
to Lisette: Ihr, Ich will mich Euch vertrauen (p. 128, Hempl.).
Lisette: Du, Du wirst ihn nie genug loben können (no apparent change in feeling to cause the change in pronoun) (p. 129).
Lisette: Ihr, Wie versteht Ihr das? (p. 129).
Damon: Sie (intimate friend).
The Widow: Sie.

Damon,
to Lisette: Ihr (124).
Lisette: Das hätte Deine Frau, etc. (astonished) (126).
Lisette: Ihr (commencing to believe her story) (126).
Leander (intimate friend): Sie.
Oronte (his cousin): Sie.
The Widow: Sie.

Oronte,
to Damon: Er, Versteh Er mich, Vetter!
The Widow. Sie.

Lisette.
to The Widow: Sie.
Damon: Sie.
Leander: Sie.

Der Misogyn.

1748.

Time: Eighteenth century: place, Germany; persons, middle-class.

Characters: Wumshäter; Laura, his daughter; Valer, his son; Hilaria, (in men's clothes, Lelio); Solbist, a lawyer; Leander, Laura's suitor; Lisette, servant.

Wumshaeter,

to Johann (servant, absent): Du.
Lisette (servant): Du.
Valer (his son: Du.
Hilaria (as Lelio): Sie.
Hilaria: Sie.
Laura (his daughter): Du.
Laura (but speaking generally): Ihr Schnadern geht, etc.
Laura: Schweig Sie doch! * *, Du willst gewiss, dass sie Deine gelben Augen auch einmal schwarz nennen soll (162). Macht Ihr mich nur blind! Wollt Ihr, etc. The final address may, and probably does, include Lelio, Valer and the others.
Solbist: Sie.
Leander: Sie.

Valer,

to Wumshäter (his father): Sie.
Hilaria (as Lelio): Sie.
Hilaria: Sie.
Laura (his sister): Du.
Laura: Ihr (sarcastic, but, perhaps, referring to women as a class).
Laura: Du.
Leander: Sie.
Lisette: Du.

Hilaria (in men's clothes, Lelio),

Lelio to Valer: Sie.
Lelio to Wumshäter: Sie.
Lelio to Laura: Sie.
Lelio to Laura (absent): Du.
Lelio to Solbist: Sie.
Hilaria to above: No change.
Hilaria to Leander: Sie.

Solbist,

to Wumshäter: Sie.
Lelio: Sie.
Lisette. Sie.

Leander,
to Laura: Sie.
Valer: Sie.
Leander to Wumshäter: Sie.

Laura,
to Wumshäter (her father): Sie.
Valer (her bother): Du.
Hilaria (as Lelio): Sie.
Hilaria: Sie.
Lisette: Du.
Leander: Sie.

Lisette (servant),
to Wumshäter: Sie.
Solbist: Sie.
Laura: Sie.

Die Juden.

1749.

TIME: First half of 18th century; place, Germany; persons, lower nobility and middle class.

Stich (robber),
to accomplice: Du.

Krumm (overseer of Baron's estate, and accomplice of Stich),
to Stich: Du.
Traveler: Sie; also when impudent (sc. 16).
Lisette (maid-servant): Sie (sc. 11).
Lisette (who is now suing for his favor): Sie, (3d sing.) and tenderly: Mein Lisettchen, weine Sie nicht, etc.; also vexed: Und Sie lacht noch dazu!

Traveler (Jew in disguise, who has saved the life of the Baron and his daughter),
to Krumm: Ihr.
Christoph (his servant): Ihr.
Baron's daughter: Sie.
Baron: Sie.

Christoph (Traveler's servant),
to Traveler: Sie.
Baron: Sie.
Lisette: Sie (Ich empfehle mich Dero gütigen Aufsicht.), also midst of unencouraged declarations of love (sc. 9, and 10).
Lisette: Sie (sing.), meine liebe Jungfer! (sc. 14).

Lisette: Sie (pl.), after some formalities, and then regularly (sc. 14).

Lisette: Sie (sing.) (sc. 19). (Sc. 20, where also L. to Chr: Er) (sc. 23).

Baron's Daughter,

to Traveler: Sie (pl.).

Baron (her father): Sie.

Christoph: Er (sc. 8).

Krumm: Er (knocking him), (sc. 12) ironical.

Krumm: Ihr Flegel! Versteht Ihr denn keinen Spass? (cuffing him).

Lisette: Du.

Baron,

to Traveler: Sie, theuerster Freund; and also after revelation that he is a Jew.

Daughter: Du.

Daughter and Traveler: Ihr.

Christoph: Ihr (may be plural in fact).

Lisette: Du.

Lisette,

to Baron: Sie.

Christoph: Sie (sc. 14).

Christoph: Er (scs. 20, 23).

Krumm: Er, Herr Vogt (contempt).

Krumm: Ihre unterthänige Magd (snuff has been offered). Sie (soliciting present) (sc. 11).

Krumm: Er (laughing); Ich bedaure Ihn.

Baron's Daughter, Sie (pert, and otherwise).

Traveler: Sie.

Der Freigeist.

1749.

SCENE: Presumably in France, though general; time, presumably 17th century; persons, middle class.

Theophan (young theolog engaged to Lisidor's daughter),

to Adrast (his friend): Sie.

Adrast (apostrophe, alone): Du.

Henrietta: Sie.

Julianne: Sie.

Lisette (maid): Sie (sing.).

Lisidor: Sie.

Araspe (cousin): Sie.

Wechsler: Sie.

Adrast (der Freigeist),
to Theophan: Sie.
Lisidor (prospective father-in-law): Sie.
Johann (servant): Du; also when very angry.
Araspe: Sie.
Henriette: Sie; even in declaration of love.
Julianne: Sie.
Wechsler: Sie.
Philane (mother of Lisidor): Sie.

Johann (servant of Lisidor),
to Lisidor: Sie.
Adrast: Sie.
Martin (servant of Araspe): Du.
Lisette: Sie (sing.).
Adrast: Sie.
Theophan: Sie.

Lisidor,
to Adrast (prospective son-in-law): Sie (first speech, sc. 3); next speech Er (a little piqued), closing with "Sage doch!" Then "Er lacht, Adrast" (laughing); then "mein gutes Bürschchen, du musst nicht glauben," etc.; then "Euch, Ihn und Theophan;" then "dir, mein lieber Adrast." After a few speeches, without change of attitude, "Ihn, Adrast." Then after Adrast's refusal to respond to suggestion of praise for Henriette, "Herr Adrast, ich will nicht hoffen dass Sie auch an der Narrheit krank liegen," etc. "Wer Henker hat Sie denn gedungen Julianne zu loben?" Finally, "Was Geier ficht Ihn an?" etc. (sc. 4) Sie. (act 5, sc. 5) Sie, (to Adrast and Theophan together) ihr, (5, 6) du (though no noticeable change in attitude).
Johann: Du; though, "Kann der Schurke nicht näher kommen?"
Lisette: Du.
Both Daughters: Ihr.
Philane (his mother): Sie, though the Göschen ed. has (5, 6) near end: "Mama, ich glaube Sie werde," etc., followed shortly by "Kommen Sie." Hempl prints in this place "Sie werden," etc.

Lisette,
to Two mistresses: Sie.
Henriette: Sie
Theophan: Sie.
Martin: Du.
Lisidor: Sie.

Henriette,
to Lisette: Du.
Julianne: Du.
Theophan: Sie.
Adrast: Sie.
Lisidor: Sie.

Julianne,
to Henriette: Du.
Theophan: Sie.
Adrast: Sie.
Lisidor: Sie.

Martin,
to Johann: Due.
Lisette: Sie (sing.).

Araspe,
to Adrast: Sie.
Theophan: Sie.

Wechsler,
to Adrast: Sie.
Theophan: Sie.

Philane,
to Theophan: Sie.
Lisidor: Du.
Adrast: Sie.

Der Schatz.

1750.

TIME: Eighteenth century; place, Germany; persons, middle-class.

Characters: Leander, Staleno (Leander's guardian), Philto, (an old trusted friend of Anselmo's), Anselmo, Lelio (Anselmo's son,) Maskarill (Lelio's servant), Raps, a baggage carrier.

Leander,
to Staleno (his guardian); Sie.

Staleno,
to Leander (his ward): Er.
Philto (a friend): Sie.
Lelio: Sie.
Maskarill: Du.
Anselmo (apostrophe): Du.
Anselmo (present): No pronoun used.

Philto,

to Staleno: Sie.
Maskarill: Du.
Lelio (his ward): Sie.
Anselmo: Du.

Anselmo,

to Philto (as related by Philto himself): Du.
Philto (absent): Du.
Philto (present): Du.
A Baggage Carrier: Ihr.
Maskarill (before recognizing him): Ihr (103, Hempl).
Maskarill (recognizing him): Du (103).
Raps (stranger): Sie (107).
Raps (aside): Du (108), "Warte, Dich will ich kriegen."
Raps (stern and decided): Ihr (112).
Raps (no change in feelings): Du (112).
Lelio (absent): Du.
Lelio (present): Du.

Lelio,

to Maskarill: Du (92).
Maskarill (suspecting him of theft): Sie. "Ha! Ha! Herr Taschenspieler! Sie haben Ihre Hände," etc., (92).
Maskarill (no apparent change): Du (92).
Philto: Sie.
Staleno: Sie
Anselmo: Sie.

Maskarill,

to Lelio (his master): Sie.
Philto: Sie.
Staleno: Sie.
Anselmo: Sie (103) (before fully recognizing him and after).
Anselmo: Du (117). "Ach! unglücklicher Vater, was wirst Du zu dieser Nachricht sagen?"
Anselmo (no apparent change): Sie (117). "Ach! Herr Anselmo, Ihr Sohn."

Raps,

to Anselmo (a stranger): Ihr (106). "Guter Vater, der Ihr mich," etc.
Anselmo (same speech): "Mein Herr, der Sie auf dem Koffer hier sitzen, könnten Sie mich," etc., (no change but to call attention).

Anselmo: Du (109). "Sondern er heisst—dass Dich!"
Anselmo (next speech): Sie.
Anselmo (as Anselmo attempts to seize him): Du (112). "Ich will Dir schon Einen schicken, der Dich besser kennen soll."

Ein Traeger,
to Anselmo: Sie.

Miss Sara Sampson.

1755.

Time: Eighteenth century; place, England; persons, middle-class.

Characters: Sir William Sampson; Miss Sara, his daughter; Mellefont; Marwood, Mellefont's old love; Arabella, daughter of Mellefont and Marwood; Waitwell, old servant of Sampson's; Norton, Mellefont's servant; Betty, Sara's maid-servant; Hannah, Marwood's maid-servant; The Tavern-keeper.

Sir Wm. Sampson,
to Waitwell (servant): Du.
Wirth: Ihr "Besorget nichts," etc.
Providence: Du. "Dank sei dir, ewige Güte!"
Sara (his daughter): Du.
Mellefont: Sie (264, ed. Göschen).
Mellefont: Du (267). "Lass dich umarmen, mein Sohn," (a natural change after Mellefont's pleadings for forgiveness).

Miss Sara Sampson,
to Mellefont: Sie.
Waitwell (servant): Du.
Marwood: Sie.
Betty (servant): Du.
Norton: Du.
Sir William (her father, delirious): Du. "Segne mich, wer du auch seiest, ein Bote des Höchsten in der Gestalt meines Vaters, oder selbst mein Vater! (263).
Sir William (next speech and continuous): Sie.

Mellefont,
to Norton (servant): Du.
Betty (servant): Du.
Sara: Sie.
Marwood (apostrophe): Du (191).
Marwood (present): Sie (196).
Marwood (as interpreted by Marwood herself): Ihr (199).

Marwood (angry): Du (207).
Marwood (no noticeable change of feeling): Sie (207).
Marwood (taking dagger away): Du (208).
Marwood (compromising): Sie (209).
Arabella: Du (202).
Arabella (determined to leave, but otherwise no change): Sie (206). "Zittern Sie nicht, Bella. Auch für Sie bin ich mit zurückgekommen," etc.
Hannah (servant): Du.
Sir William: Sie.

Marwood,
to Mellefont (in letter): Sie (191).
Mellefont: Sie (196).
Mellefont (familiarly): Du (197).
Mellefont (sarcastic): "Gut, dass Sie dieses Briefes gedenken. Sagen Sie mir," etc. (199).
Mellefont (angry): Du. "Geh, Elender, und lern erst ihre Mutter kennen," (206).
Mellefont (attempting to control herself): Sie (206). "Nun sagen Sie es noch einmal, ob Sie," etc.
Mellefont (angry): Du (207).
Mellefont (pleading for dagger): Sie (208). "Geben Sie mir ihn wieder, den verirrten Stahl," etc.
Hannah (servant): Du.
Arabella (her daughter): Du.
Sara: Sie.

Arabella,
to Mellefont: Sie.
Marwood: Sie.

Waitwell (servant),
to Sir William (master): Sie.
Sara (absent): Du (177).
Sara (present): Sie (215).
Wirth (provoked): Du.

Norton (servant),
to Mellefont: Sie.
Sara: Sie.

Betty (servant),
to Mellefont: Sie.
Waitwell (impatient): Er.
Sara: Sie.

Hannah (servant),
to Marwood: Sie.
Arabella: Sie.

Tavern-keeper,
to Waitwell: Du.
Sir William: Sie.

Servants,
to Marwood: Sie.

Philotas.

1759.

TIME: Before Christ; place, Greece; persons, king and soldiers of rank.

Characters: Aridäus, king; Strato, general of the king's army; Philotas, a captured Spartan youth; Parmenio, a soldier.

Aridaeus,
to Philotas (the boy captive): Du.
Strato (his general): Du.

Strato,
to Philotas: Du.
Aridäus (his king): Du

Philotas,
to Strato: Du.
Aridäus: Du.
Parmenio: Du
Apostrophe (always): Du.
Apostrophe (to himself): Du.
Apostrophe (to thought): Du.
Apostrophe (to heart): Du.

Parmenio,
to Philotas: Du.

Minna von Barnhelm.

1767.

TIME: 1765; place, Berlin; persons, lower nobility, and commoners

Major von Tellheim,
to Just (his servant): Du.
Wirth: Sie.
Dame in Trauer: Sie.
Bedienter: Ihr.
Minna: Sie.
Werner (a friend, but lower in rank): Du.
Franziska (servant): Du.
Jäger: Sie.
Graf von Bruchsall: Sie.

Minna von Barnhelm,
to Franziska (servant): Du.
Wirth: Sie.
Just (servant): Er.
Tellheim (her lover): Sie (p. 41 ed. Heath),
Tellheim: Du (45), (pleading) Deine Hand, lieber Bettler! but (117) in the same tone, Hören Sie mich doch! Sie betrügen sich! etc.
Tellheim (no sufficient change) next speech: "Was ist Ihnen? Wo wollen Sie hin?"
Riccaut: Sie.
Werner: Er.
Graf von Bruchsall (her uncle): Sie.

Franziska (servant),
to Minna: Sie.
Wirth: Er (29). "Und wünschen Ihm auch einen guten Morgen, Herr Wirth."
Wirth: Sie (30), (provoked) "Nun, Herr Wirth, so setzen Sie anstatt Kammerfrau Kammerjungfrau," (and so continuously).
Just (servant): Er.
Werner: Er (59). "Will Er wohl so gut sein und so lange hier warten?"
Werner (no change): Sie (66). "Sind Sie noch da, Herr Wachtmeister?"
Werner: Er (69) (no apparent change); "dasmal will ich es Ihm verzeihen."
Werner: Sie (84). "Ihre Dienerin, Herr Wachtmeister; was bringen Sie uns?"
Werner: Er (122), (no apparent strain of relation). "Seh' Er mich einmal an, Herr Wachtmeister."
Tellheim: Sie.

Just (servant),
to Wirth (in sleep): Du.
Wirth (cross): Er, and regularly thereafter.
Tellheim (his master): Sie.
Servant (a stranger): Er.
Ring (apostrophe): Du.
Werner: Du.
Minna: Sie.
Franziska: Sie (sing. 3. per.).

Paul Werner,
to Just (servant): Du.
Franziska: Sie (3. per. sing.).
Wirth (present): Er (56).
Wirth (absent): Du (57).
Tellheim: Sie.
Himself: Du.
Minna: Sie "Ihro Gnaden."

Der Wirth,
to Just: Er.
Minna: Sie "Ihro Gnaden, Dero Namen" (30).
Franziska: Sie (3. per. sing.).
Werner: Er.

Eine Dame in Trauer,
to Tellheim: Sie.

Ein Feldjaeger,
to Tellheim: Sie.

Riccaut de la Marliniere,
to Minna: Sie "Ihro Gnad."

A Servant,
to Just: Er.

Graf von Bruchsall,
to Tellheim: Sie (120).
Tellheim: Du and Sie in the same speech (120). "Ich höre es; wenn dein Mund nicht plaudern kann, so kann dein Herz doch reden. Ich bin sonst den Offizieren von dieser Farbe (Auf Tellheim's Uniform weisend) eben nicht gut. Doch Sie sind ein ehrlicher Mann," etc.

King's Letter,
to Tellheim: Ihr. "Ich thue Euch zu wissen," etc.

Emilia Galotti.

1772.

Time: Seventeenth century; place, Guastalla; persons, nobility, officials, commoners, and robbers.

Characters: Emilia Galotti; Odoardo and Claudia, Emilia's parents; Hettore Gonzaga, prince of Guastalla; Marinelli, the prince's chamberlain; Camillo Rota, one of the prince's advisors; Conti, an artist; Graf Appiani; Gräfin Orsina, cast-off mistress of the prince; Angelo, and some other servants.

Emilia,

to Claudia (her mother): Sie.
Appiani (her intended husband): Sie.
Battista (strange servant): Er.
Marinelli: Sie.
Prince: Sie.
Odoardo (her father): Sie.
Rose (apostrophe): Du.

Odoardo,

to Claudia (his wife): Du.
Pirro (servant): Du. "Geh und führe mein Pferd.',
Orsina: Sie (77, ed. Cotta, Bibliothek der Weltlitteratur).
Orsina (thanking her for the dagger, but otherwise no change): Du. "Liebes Kind, wer wieder sagt, dass du eine Närrin bist, der hat es mit mir zu thun," (80).
Marinelli: Sie.
Appiani (absent, dead): Du.
Prince (absent): Du.
Prince (present): Sie.
Emilia (his daughter): Du.

Claudia,

to Odoardo: Sie (40).
Odoardo (no apparent change): Du (43, and continuous thereafter).
Pirro (servant): Ihr.
Emilia (her daughter): Du.
Appiani (her intended son-in-law): Sie.
Battista (strange servant): Du.
Marinelli: Sie (64).
Marinelli (no apparent change from the few speeches preceding): "Was konnte meine Tochter dafür, dass Appiani dein Feind war?" (65).
Marinelli (in next pronoun used): Sie (66).
Marinelli (angry): Du. "Was ehrliche Mörder sind, werden dich unter sich nicht dulden!" etc.

Prince.

to Servant: "Lasst ihn rufen."
Conti: Sie.
A Picture: Du.
Claudia (absent): Sie. "Was Sie dafür wollen, ehrliche Mutter," (33).

Odoardo (absent): Du.
Odoardo (present): Sie.
Emilia (absent): Du.
Emilia (present): Sie.
Marinelli (his chamberlain): Sie (33).
Marinelli (stern and angry): Er (35).
Marinelli (greatly excited): Du (36).
Marinelli (no cause for change): Sie (36).
Marinelli: Du (94). "Hier, heb ihn auf.—Nun? du bedenkst dich?"
Emilia Bruneschi (absent): Du.
Camillo Rota: Sie.
Battista: "Geh, lauf, Battista."
Orsina: Sie.

Marinelli,
to Prince: Sie (33).
Prince (sarcastic): Er (69). "Er erlaube mir, Ihm zu sagen."
Prince (begging his pardon): Sie (69).
Prince: "Eurer Durchlaucht," (83).
Appiani: Sie (no alteration in pronoun by change in feeling).
Appiani (absent and probably killed): Sie (58). "Ha, Herr Graf, der Sie nicht nach Massa wollten."
Angelo (robber): Du.
Emilia: Sie.
Battista: Du, "Geh."
Claudia: Sie.
Orsina: Sie.
Odoardo: Sie.

Camillo Rota,
to Prince: Sie.

Conti,
to Prince: Sie.

Graf Appiani,
to Emilia: Sie.
Claudia: Sie.
Marinelli: Sie.

Orsina,
to Marinelli: Sie (71).
Marinelli (sarcastic): Du (73). "Ist dir das zu hoch, Mensch?"
Marinelli: Sie (73).

Providence: Du.
Emilia (absent): Du.
Odoardo: Sie.

Angelo (robber),
to Pirro (a servant): Du.
Pirro and Galotti family: Ihr, "Ist es eure?"
Marinelli: Sie.

Pirro (servant),
to Angelo: Du.

Battista (servant),
to Marinelli: Sie.
Claudia: Sie. "Ihre Gnaden."

Nathan der Weise.

1778-9.

Place: Jerusalem: time, 1193; persons, royal, noble, and middle-class.

Characters: Sultan Saladin; Sittah, his sister; Nathan, a rich Jew in Jerusalem; Recha, his adopted daughter; Daja, a Christian, but in the house of the Jew as companion of Recha; a Dervish; Patriarch of Jerusalem; a Lay-brother; an Emir of the Sultan; Servants.

Saladin,
to Sittah (his sister): Du.
Dervish (his treasurer): Du.
Sittah (including dervish): Ihr.
Nathan (stranger): Du.
His Brother (apostrophe): Du.
Templar: Du.
Servants: Du.
Emir Mansor: Du.
Recha: Du.

Sittah,
to Saladin (her brother): Du.
Dervish: Du.
Saladin (including absent Templar): Ihr.
Recha: Du.

Nathan,
to Daja (companion of Recha): Du.
Daja (including Recha): Ihr.
Recha: Du.

Dervish: Du.
Templar: Ihr.
Saladin: Du.
Lay-brother: Ihr.
God: Du.

Recha,
to Nathan: Ihr.
Daja: Du.
Templar: Ihr.
Sittah: Du.

Daja,
to Nathan: Ihr.
Templar: Ihr.
Templar (probably gone): Du (I, 786, lines as in ed. Cotta).
"So geh, du deutscher Bär!"
Recha: Ihr (II, 368).
Recha: Du (III, 23; no way of accounting for this change).
Recha: Ihr (III, 179; no apparent change).

Templar,
to Lay-brother: Ihr.
Saladin (absent): Du (I, 705).
Saladin (present): Du (IV, 273).
Nature (apostrophe): Du.
Daja: Ihr (I, 763).
Daja: Du (III, 109).
Daja: Ihr (III, 171; no apparent change).
Nathan: Ihr.
Recha: Ihr.
Recha (absent): Du.
Patriarch: Ihr.
In Apostrophe: Du.

Dervish.
to Nathan: Ihr.
Saladin: Ihr.
Sittah: Ihr.

Patriarch,
to Templar: Ihr.

Lay-brother,
to Templar: Ihr.
Nathan: Ihr.

Emir Mansor,
to Sultan Saladin: Du.

Dialect Word-List.—No. 4.

BY W. H. CARRUTH AND PAUL WILKINSON.

Where not otherwise noted the locality is Northeastern Kansas.

aber nit: "over the left." General.

ad burn: dad burn. A mild oath.

afore: before. Int. Dic. says 'archaic.'

allee samee (sometimes "**allee samee in Dutch**"): all the same, for emphasis; nevertheless.—Ks.

all overish (feeling): "creepy" feeling.—Mo.

all right all right: emphatic. General.

ante over or **ant'ny over:** name of a children's game, which consists of two players or sides standing on either side of a building and one tossing a ball to the other, at the same time shouting "ante over," The catcher then returns the ball in the same manner.

ante room: card room.

any old——: used in "any old thing," "any old street," etc., to express indifference, or absence of choice.—General.

ast: ask.

back talk: retort.—General.

back up a car length: to be thus addressed signifies that your tale is improbable and should be modified. From the R. R.—Mo.

bang up: very fine.

barmy in the crumpet: intoxicated.—England.

beat the band: as "He ate to beat the band." Emphatic.—General.

beauties: American Beauty roses.—Western.

beneath the clover: dead.

biff: a blow.—Mo.

bike: bicycle.—General.

blackman: a children's game, general played at school. The players "choose up" and take sides; a leader cries "blackman," and the players run to the other side, each player endeavoring to catch an opponent in passing. The captive then plays on the other side.

blood kin: kin.—New Eng.

blood medicine: liquor.—Western.

blow off for ——; "He blew himself off for a new hat."

blue sky: worthless. One's investment turns out to be "blue sky."—General. (German: blauer Dunst).

bob tailed flush: poker term.—General.

boozing ken: tavern. Term found in an old English novel in thieves' language. It suggests "booze."

bronc: bronco.—Western.

bug house: the head of an erratic person.—Mo.

bull pen: operating amphitheatre of a medical college.—Genl.

bung out, adj.: empty.

burn: squander, as "He has money to burn."—General.

busy as a dog in flea time.—Mo.

bye-m-bye: bye and bye.—West and South.

call down: to humble one.

call the turn: to predict correctly. From cards.—General.

chase yourself: "get out."—General.

chessy cat: an inquisitive person.—St. Joseph.

chickory: all kinds of coffee.—Western.

chili also **chili sauce:** a firey sauce made from red peppers.—General.

chin music: plenteous talk.

chuck up: to cheer up, intr.

churp up: to encourage.

circuit chaser: a "rounder."—Western.

close one's peepers: to go to sleep.

close your face: "Shut your mouth."—Kans. and Mo.

collar: to "nab."

condem: mild substitute for 'damn!'

cowardy calf: a young coward. Used chiefly by youths.—Kas.

crackerjack: an expert.—General.

crazy as a loon: General.

cross the pike: "The nicest fellow that ever crossed the pike."—East.

crow-hop, v: to 'crawfish,' to back out.—Kans.

cut ice: to affect; as, "It cuts no ice with me."—General.

dag: same as "dab."

dag on: dog on. A mild oath.

dark brown taste: peculiar taste in the mouth after intoxication.—General.

dead one: a "chump."

dead: a general intensive, as dead loads, dead game, etc.

dem: mild oath, see condem.

die doing: as, "I could die eating candy.—General.

dinkey dink: see "rinkey dink." The "razzle dazzle," puzzle.—Eastern; recent.

do dirt: to treat meanly.—General.

do the correct thing: to act generously.—General.

do right(thing): same as last.—General.

do up brown: to "do up" completely.—General.

do to a finish: same as last.

do to a frazzle: same as last.

I dont think: "over the left." I find this used by Sam Weller in the Picwick Papers. It seems to have revived spontaneously.

dough: money.—General.

down the pike: cp. "cross the pike."

draw: draw poker.—General.

d. t.'s: delirium tremens.—General.

draw a blank: make a failure. From the lottery.—General.

ease down: to let down gradually.

ease up: to lessen a load.

easy mark: a guileless person.—General.

easy street, also **shady side of e. s.** (to live on): (to be in) easy circumstances.—General.

electrics: electric lights.—General.

every which(a) way: all directions.

eytalics: Italians. Used by printers.—W. A. White.

fairy tale: an improbable story.—General.

fan: an enthusiast. From fanatic(?).—General.

fill with hot air: tell an improbable story to.

flock by one's self: act in a reserved manner.

fly the blue pigeon: cast the lead. By sailors.

fortieth: same as "forty leventh" and "steenth."—General.

(like) forty: for emphasis.—General.

free for nothing: emphatic redundancy.—General.

frills: entrees to a meal.

frost: cool reception.—General.

gash(gosh) ding: mild oath.

gazubo: a "jaw." From "gaze about(?)"—Mo.

gueezer: a "jay."(=gazer?)—General.

get down and scratch the paint off: said of a person of an inquiring disposition.—Mo.

get 'em: to have the d. t.'s.

get out of town: move on. From R. R.—General.

get stuck: to lose in gambling, or speculation. —General.

ginger: spunk.—General,

ginger up (tr. and intr.): to liven up.—General.

git-ar: guitar.

give more sand: to increase speed under difficulties. From R. R.—General.

glad hand: hearty hand shake.—General.

glad rags: "Sunday-go-to-meeting" clothes.—General.

going south: taking a favorable turn.

(be)good to yourself: a common parting expression.—Gen.

gray: a "jay."

gray matter: brain power.—General.

grouchy: grumpy.—General.

ground hog case: absolutely necessary.—General.

happen: "He is the nicest fellow that ever happened."—Mo.

happy as a clam:—General.

hard nut: a bad case.—General.

have on drinks: to be intoxicated.

heart burner: a drink of liquor.

hey rube: a farmer. This cry is also used by circus employees as a slogan in case of a "scrap."

high ball: recent popular drink, composed of whiskey and seltzer.—General.

high kicker: fast person.—General.

his nibs: ironical allusion to a pretentious person. Also as "old man."

hog yoke: quadrant or sextant used by mariners.

hokey pokey: Candy.—Mo.

hot stuff: anything excellent.—General.

hots: cry of the street vender of hot tomales, tenderloins, wienerwursts, etc.=General in cities.

hunder: hundred.—East.

icy mitten: cool refusal.—East.

I'm blowed: I'm done. Also exclamation of surprise.

infalid: invalid.

item chaser: reporter.

james preserves: "jim jams."—General.

jasper: farmer.—General.

jerkwater: insignificant.

jolly: flatter.—General.

Jones, he pays the freight: never mind the expense. From the advertisement of a scale manufacturer of Binghamton, N. Y.—General.

journalese: reporter's style. Used by Rudyard Kipling in an American conversation.

kerwhack: the noise of a resounding blow.

kissing party: a "party" at which games are played in all of which the forfeit is a kiss.

kissing game: one of the above games.

knock silly: paralyze.—General.

lacteal fluid: milk.—General.

lala: a "lulu."—General.

laugh fit to kill: "die a laughing."

lay down on: refuse to proceed further. From horses laying down on the harness.—General.

lead pill: bullet.—West.

lean up close to luck: to run on a close margin.—Eugene Ware.

leggy: tired from walking.—English.

let her out a piece: relax vigilance. From the R. R.—General.

lilacs: the beard.—General.

lip: "back talk."—General.

live one: active person.

lonesome: as "All by my lonesome."

louse cage: hat.

marble heart: cool reception; as "She gave me the 'marble heart.'"—General.

mark: innocent person.—General.

meat axey: "hatchet faced."—Mo.

meaning?: an interrogatory, usually an interruption.—Western.

morning: good morning; in greeting.—General.

mouth filler: large word.

mud: mortar.—General.

mug up: "feed one's face."—New England.

mushroomery: place for growing mushrooms.

my eye: exclamation of surprise or admiration.—General.

national plum tree: the whole system of government appointments.

nearder: nearer.

nervous: nervy.—General.

nester: a "mover."—Texas.

night school: in "You should go to night school." You need information.—Mo.

nit: "over the left."—General.

nominate your poison: "what will you have to drink?"—West.

nope: no.

nose artist: bar keeper.

not a marker: "that don't compare."—General.

not nothing: the double negative—very common.

not on your picture / tintype: "Not by a long shot."

not so many / much / warm: a form of expression reflecting on a braggart's pretentions, and implying superiority in the one speaking.—General.

not to be sneezed at: of some importance.—General.

nut college: lunatic asylum.—Chicago.

nutty: demented. From "cocoanut?"—General.

off one's nut: mistaken.—General.

one: applied by one engaged person to the other; as, "My one."—Mo.

on the bum: very bad.—General.

on the hog: hoggish.

on the hog train: in hard luck. From R. R.—General.

on the run: defeated; as, "I have them on the run."—General.

on to: aware of anything; as, "He is on to me."—General.

oodles: enormous quantities.

open, cross barred, or kivered: they only have one kind of pie in south Missouri—apple—and the waitress at the hotel asks what kind you wlll have, "Open, cross barred, or kivered?"

oversea plunder: articles collected by seamen on their voyages. In a recent novel by Rudyard Kipling.

ownest own: term of endearment.—Mo.

pail: to milk. "Pail the cow."

paralyze: to "do."

parky: weather which is a little fresh.—English.

pass in a crowd: do; term of approbation; as, "You'll pass in a crowd."—General.

pay the freight: stand the expenses.

peach: a very fine anything.--General.

peanut heaven: the highest gallery in a theatre.—General.

percolate away: gradually disappear.

phenom: phenomenon.—General.

pig tail: a small boy who stands behind ball players and chases the ball. Also as verb.—Kansas and Mo.

plant: bury.—General.

play in (good or bad) luck: be successful or otherwise. From cards.—General.

pome or po-um: poem.

popocrat: same as Demopop. First noted by me in Chicago Tribune. Now general, I believe.

puccon: pecan.—La.

pull your freight: get out.

pump, pump, pull away: children's game after the fashion of "crack the whip."

pungle: to solicit. "He pungled around and got quite a lot."

push: the "procession;" as, "He is in the push."—General.

rag: a negro dance.—General.

rake in / down: to "knock the persimmons."—General.

rake off: the profits.—General.

raw: crude; said of a joke, etc.—General.

resock into jail: used by Eugene Ware.

rig: to "guy."—General.

rinkey dink: the "razzle dazzle."—Eastern.

rockers on his throne (to have): to have an easy time.

roost high: act in a cautious manner.—General.

rooter: an enthusiast at a game.—General.

rube: a farmer.—General.

rustle: to run off cattle.—Western.

run for one's money: to have a good time while the money lasts.—General.

samwich: sandwich.—Kans.

saw wood: as, "To saw wood and say nothing." To persevere. —General.

scare cat: "fraid cat." A timid person.

see: abbreviated question=Do you understand?—General.

separate from, v.: to spend, as money.—General.

set one's corks to bobbing: to excite; as, "Wouldn't that set your corks to bobbing?" "Wouldn't that 'jar' you?"—Mo.

shake: to desert, to get rid of.—General.

shoemaker's black team: on foot.

short grass country: the western third of Kansas.

show me: substitute for, "I don't understand." We have an expression in Missouri, "I'm from Missouri: you'll have to show me." Hence show me.—Mo.

shriner: member "Ancient Arabic Order of the Mystic Shrine," a Masonic order.—General.

shuck: to undress.—Mo.

side-door sleeper: a box car.—General.

sir, to you: how do you do.—Mo.

skin and hang hide on the fence: to 'do up.'

skin game: confidence game.—General.

slickery: slippery.

slim jinks: a slim person.

smear: a small portion. Also to put in a valuable card under the protection of your partner's high card—General.

snake: to remove anything stealthily.—General.

snark: an odd genius.—Kans. and Mo.

sniz: to smirk around.—Mo.

sod buster: farmer.—General.

so long: good bye.—General.

sooner: a mongrel cur.

south pawed: left handed.—General.

spellbinder: newspaper reporter.—Western.

spigot turner: a bar keeper.--General.

spinach: Whiskers.—Mo.

spit cotton: to have a dry mouth.—General.

square: to make right.—General.

a square one: an honest person.—General.

squeegee: a stingy person.—Mo.

squinch: to smirk.—New Eng.

sqush: to squeeze.

stack up against: to encounter, poker term.—General.

stand one for: to represent.—Kans.

starter: a beginning.—General.

stem winder: a first-class anything.--General.

sticker weed: one of several weeds, the leaves or seeds of which stick to clothing.

sticktoitiveness: pesseverence.

stiff upper lip: courage. (Can any one tell why? The upper lip is always stiff; it is the lower lip that is hard to control.)

straddle bug: a mugwump. Especially applied during the last campaign to a person who was neither a "gold bug" nor a "silver bug."—General.

(**the**) **straight and narrow**: a religious life.

stuff's off: it's ended.—General.

stuff: money.—General.

stump: to dare; among youths.

suffer good health:—Mo. and Kans.

suit down to the ground: to suit exactly.

Sunday-go-to-meeting: usually applied to "store clothes."—Kans.

throw down: the advantage.—Mo.

turn up missing / minus: to fail to appear.—General.

tonic: liquor.

talk an arm off: to talk at great length.—General.

typewriter: the queen in cards.—Mo.

tank, v.: to take a drink.

tank, n.: capacity for intoxicants.

tyke: a little child.

tame cat: a quiet youth.

top the lot / bunch: to stand at the head.—Kans. and Mo.

(that'll be) loads: that will be a great sufficiency.—Mo.

(that's) straight (goods): that is a fact.—General.

to: at or in; as, "It's to Lawrence."—General.

that goes: that's the truth, or that is satisfactory.—General.

tin pot railroad: a small road.—Western.

till the cows come home: an indefinitely long time.—Gen.

trimmed victuals: food gotten up in good style.—General.

there are others: you are not the only one.—General.

tippy up: a ball knocked up easily to be caught.

teeter totter: to swing up and down on opposite ends of a plank supported in the center.

turn up one's toes: to die.—Kans.

tired feeling: condition of being bored.—General.

think tank: the intellect.—General.

turn a wheel: usually negative; as, "They never turned a wheel." They didn't do a thing.—General.

twofer: cheap. From "two for a nickel" cigars.—General.

what it is?: what is it?—Kans. and Mo.

wheels (in the head): cranky ideas.

writer up: a special reporter.—Kans.

what d'ye soy: what do you say?—Mo.

winner: an excellent anything.—General.

warm under the collar: aggravated.—General.

what's the best (word) with you: Mo. and Kans.

warm (proposition): excellent proposition, and warm, in same sense generally.

world by the tail, (to have the): to be master of the situation.

wind teasers: whiskers—General.

young uns: children.

you can gamble on it: expression of certainty.—General.

Editorial Notes.

Professor James T. Hatfield, of Northwestern University, has published (D. C. Heath & Co.) a pamphlet of exercises in German composition based on "Hoeher als die Kirche."

Professor A. R. Marsh, of Harvard, formerly of this institution, has issued through Ginn & Co. a handsome edition of Galdo's "Dona Perfecta," with a brief but helpful Introduction and judicious Notes. In view of the scarcity of well-edited Spanish texts this is very welcome.

The Modern Language Association of America has issued Number 2 of its 12th volume of publications, containing papers on Spenser's Imitations from Ariosto, the Christian Coloring in the Beowulf, The Hildebrandslied, and Fernan Perez de Guzman.

"The Whitney Memorial Meeting" is the title of a handsome volume. edited by Professor Lanman, of Harvard, containing a full account of the First American Congress of Philologists which met in memory of the late W. D. Whitney. Among other matters are the chief memorial addresses, and a complete Whitney Bibliography of 360 numbers. There is also a very fine portrait of Professor Whitney. Published by Ginn & Co.

The first number of the *Journal of Germanic Philology*, edited by Professor Gustaf E Karsten of the University of Indiana, has been issued from the press. Some of the titles in this first number will give an idea of the scope of the new journal: The Home of Walther von der Vogelweide, Middle English -wo- -wo-, The Voiced Spirants in Gothic, Phonetical Notes, Shakspere in the Seventeenth Century. The existence of such a journal under such able management is an index of the tremendous advance in importance of modern language studies, and at the same time a cause for congratulation to all specialists.

The University of Chicago has recently published Number III in its series of Germanic Studies. It is a volume of fifty-six pages containing hitherto unpublished poems by Heinrich Kaufringer, a Bavarian poet of the 14th century. The discovery of these poems in a Berlin manuscript, and the editing and publication of them is the work of Professor H. Schmidt-Wartenberg, of the University of Chicago.

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The Duty of the State to the Scholar.*

BY OLIN TEMPLIN.

In some way I have come to associate the Phi Beta Kappa address with a discussion of some form of the Duty of the Scholar to the State. It is unfortunately true that there has been reason for urging the scholar to discharge his political responsibilities; but it is not to be assumed that he, more than others, is derelict in this matter, nor indeed, less influenced by patriotic motives. The scholar may not be very ostentatious in his political transactions, but that he can and does make his influence felt is none the less certain. But, with your permission, I wish to reverse that formula, and call attention to the Duty of the State to the Scholar.

It cannot be contended that society, directly or through its organized form, the state, can be under obligation to any individual as such. The rights of society are and forever must be paramount to the rights of the individual, so that every obligation existing between them must be on the part of the individual towards society; this because the interests of all are involved in its welfare, and ultimately all cannot be indebted to one. Another reason is that society is in a relative sense immortal. The race throughout all future time is involved in the condition of society as it exists at any moment. But as the individual is indebted to the section of society of which he is a member, so that section is obliged to the existing race, and the latter to humanity that is to be. Now the scholar cannot claim immunity from the workings of this general rule. To him as a mere individual society owes noth-

*Annual Address before the Phi Beta Kappa Society.

ing, and from it he can claim nothing. However, he may stand in such a relation to the existing race or to humanity without regard to place or time that his own section of society may seem to owe him much. If the wisest of men have been persecuted, the crime was against the race and the spirit of Truth in the world. The people have stoned their prophets many times, but their offense was not against the prophets as mere men. Those prophets belonged to all humanity, and all humanity condemns the persecutors and execrates their memory. It is, therefore, apparent that if the state owes anything to the scholar it is because he belongs to the greater state, humanity or society altogether—because he is its ordained and indispensable servant. And the nature of that duty of the state grows out of the nature of his relation to the race. I think such a relation can be shown to exist.

In considering this subject let us first agree upon who the scholar is, then find out his relations to society; then will the duties of the state to him, if there be any, be determined. Who, then, is the scholar? Well, whatever he is, he is not merely one who is well informed, erudite, learned, although wide learning will have great value to him, as for others; indeed, it will have greater value for him than for any other, but it will not make him. Neither is he one who possesses unusual shrewdness, smartness or native keenness of insight. Nor does mere fertility of resource, extraordinary mental productivity, constitute scholarship, and characterize the scholar. And he is not one who merely loves the truth, or has great curiosity and wonder. Even this scientific emotion may disqualify one for intellectual pursuits and rational judgment. It might be asserted further that the scholar can never be a born scholar but must be a growth. The scholar is rather a complex of all these qualities reduced to scientific form. He is a person in whom the capacity for knowing, thinking, and finding out is most highly developed. Ordinarily he appears to have been endowed with certain natural gifts which have been developed by healthy use. Familiarity with the best thoughts of the race and general scientific facts, as well as a detailed exact knowledge of some special phase of truth he must acquire, but such information must be to genuine scholarship what mere sensation is to the intellect. It may be well, too, for him to have a thorough training by wise and skillful masters, but such training often involves the loss of much of native ability, spontaneity, originality. I suspect that the very best preparation for the scholar is the serious, sustained effort at being a scholar. The result, in any case,

must be the ability to know the truth when in its presence, to think the right thought upon occasion, to grasp the full import and meaning of things, to judge accurately of their value, and to know the true character of the standard of value. Now all this is possible only through the possession and valid use of broad and fundamental principles of reality. So the scholar's knowledge will differ from that of another in that his is a knowledge of ever broadening principles and not merely of facts, and his thinking will be peculiar in that it is a logical use of such principles and not a mere association of ideas. The scholar, therefore, knows, and knows that and what and how he knows. He also knows—and this is important—that, what, and why he does not know. He also knows how by looking and thinking he can find out. But above and beyond all this he has the spirit of truth, variously called the scientific, the artistic, the literary and the philosophical spirit. The true has a mysterious yet unwavering fascination for him; this, probably because of his abiding faith in the identity of the true, the beautiful and the good. And do you know that at that point scholarship and religion touch each other? The fundamental principle of all religion, though stated in many different forms, is the instinctive faith that the supreme Reality of the Universe is good; that in some way "good will be the final goal of ill;" the sovereignty of God. The scholar feels that all truth as such is one, and that it has eternal worth; that it is an infinite system imperfectly mirroring itself in his own little soul; that it is, in ultimate fact, the very person of God. He amends the theologian's formula to read that God is, not will be, the substance, not goal, of all. The final goal to be sought, he believes, is the complete comprehension of how these things can be. After all, their difference is a little matter of tense, and we can wait. Let it not be said that this is an idle fancy. These views have been stated explicitly by the foremost writers of the day in both provinces. And so the very crown of pure and undefiled scholarship is the constantly ardent enthusiasm in the pursuit and possession of the truth as such, because of its divinity. I know that in these later days there has been much division of labor among the scholars; that, in other words, scholars have become specialists; and that, becoming necessarily absorbed in their own narrow field of operations, they forget and even deny the stupendous universe about them, fail to sympathize with other just as honorable co-workers, and lose sight of this absolute and ideal end of all true scholarship. But I do not believe that it is as general or as serious as it appears to the casual observer. Of

course, intense cultivation is possible only after allotment of parcels of domain; but citizenship in the sovereign republic of letters is not thereby lost, and, as in the state, broad, healthy patriotism will be enlarged by such individual holdings. A little local pride is not to be taken for the spirit of secession or anarchy. But let no one who aspires to the rank of the scholar forget that this breadth of view and of interest and of ideal end is his very life. Finally, let it be asserted that the true scholar is also a good man. This is nothing but the ancient Socratic principle that wisdom and goodness are one, that the truly wise will necessarily be truly good. The truth and the love of it are the great ethical antiseptics.

Like the Greek Stoic who had described the true Stoic in such exalted terms that he failed to find a single living example among all the men of his time, so we may have to admit that there is no one answering our description of the scholar. But that is no matter. There are those who approximate the ideal in various degrees, and who may therefore be considered for this purpose in so far, only, as they do possess such qualities of the scholar; and to the extent that any person possesses these scholarly characteristics he may claim the rights of the scholar.

Such then is our definition of the scholar. How is he related to society? Society is but an aggregation of persons, and the character of these persons constitutes the character of society. A person is a conscious being with a will and an intellect. The will is his capacity and tendency to act, the intellect his capacity to know and find out. The will embraces numberless instincts and habits which, during life, become modified to a varying degree by the intelligence. The natural will, as instinct, is somewhat adjusted to the person's needs. It will lead him to do many of the things most necessary for his welfare and for that of the race. But it alone would not take him out of base savagery—hardly into it, in fact. From his earliest days his innate will must be enlightened, directed and controlled by intelligence. Life is largely a struggle for the existence and advancement of the individual and of the race against those conditions which the intellect and not the will is prepared to encounter—indeed, even the intellect as it is at present is often inadequate for the task. Hence those who are unintelligent are unable to keep up the struggle for themselves, are worthless to those dependent upon them and fail to survive. Now the scholar in society is what the intellect is to the individual. As a man needs sense, so a state needs scholars. Society is made up of persons who have, some more, some fewer of the qualities of the scholar.

It is struggling incessantly against conditions which are to be encountered successfully only by the most mighty intellects—indeed, they, too, are sometimes inadequate and then society fails to that extent, and in great crises may not survive. Four years before the civil war Theodore Parker said: "If our educated men had done their duty we would not now be in this ghastly condition we bewail." Possibly he was right, but I am much more confident that if those who had tbe direction of public affairs had been educated men America would not have had to pass through that ghastly period. It is highly probable that the influence of a representative scholar, George William Curtis, saved us from civil war on a later occasion. The scholar, as the one who knows best what ought to be done, and known under numerous and diverse titles, has determined the more creditable chapters in the history of the race, even though the soldier and king have appeared to make them. In these later days the professional scholar who gives himself unreservedly to scholastic pursuits, is becoming more and more necessary to society and state. Not that he should be placed in office or even public place. Plato's idea of the philosopher-king is a wonderful allegory—a plan, as he says, laid up in heaven—not to be realized on earth. While much intelligence or scholarship is necessary in the administration of affairs, the professional scholar can never serve the state so well as in retirement. Great military campaigns cannot be safely planned amid the confusion of battle or even of camp life; and it sometimes happens that a strategist who can formulate such plans most successfully is the last man in the service to lead the assault. Neither are far-reaching policies of state worked out in the houses of parliament, although the fiery orators may be confident of the contrary. Parliaments and congresses are assemblies of the people for the ratification and acceptance of principles, thought out and demonstrated long before, it may be, by quiet souls perhaps unknown, whose intellects, more clear and free, outran traditions and customs and possibly consciences, and proved that they were right.

If this be true in affairs of war and state, how much more true must it be of civilization and of life. And after all the scholar's highest work cannot be in or by means of the state. The state is merely a great corporation, an instrument which society employs in supplying some of its most ordinary necessities, its shelter and food, so to speak. A great American has said that the object of human government is human liberty. It may be so; but certainly that is not the object of life. "It is not all of life to

live," even in freedom. It is the scholar's specific function to discover the higher life and realize it in himself and in society. There are gradations in living and there is always an ideally better which ought to be realized in the individual and society. This is what Spencer means when he pleads for greater depth of life, even at the expense of breadth or amount. Life without what is vaguely called culture, even in the best conducted state, would be ignominious. In the advance out of such a "state of nature," more than in the simple development of the state, will it be necessary to be advised and guided by those who know and can find out. If the ordinary instincts are to be followed, little progress will be made. Indeed, instincts demand amount of life rather than quality. And let us not forget that this higher life is and must always be complex and ever more complex. It will not submit to any simple formula. Growth is "from the homogeneous to the heterogeneous," and a demand for simplicity and finality is a demand for degeneration. If the world will not contain the books that are to be written, then an asteroid or other celestial body must be acquired for a library. The museums, and galleries of art, and magnificent architecture, and schools of all sorts, and learned societies, and scientific laboratories and improved conditions of living,—all these and the others which it has not yet entered into the heart of man to conceive must, and in spite of all opposition and temporary delay will, have room.

The higher life cannot be maintained by its own momentum. It must be protected, nurtured, restored, revived, from generation to generation—from day to day. Like all other life, it is subject to a process of acquisition and destruction of constituent particles.

The scholar, then, is by virtue of his office, an educator. He is the chief factor in the substitution of the ideal, artificial selection for brutal natural selection. It is he, more than any other, who is building up a powerful intellect in mankind, strong enough to subdue and enslave blind, cruel, native will. I venture the opinion that, for example, if all could be known (which, however, is impossible,) humanity would be found more indebted to Plato than to Cæsar, to Spinoza than to Charlemagne, to Adam Smith than to Marlborough, to Kant than to Bismarck, and to John Stuart Mill than to the Duke of Wellington. Without Oxford and Cambridge, Britain would have deserved Napoleon's sneering epithet, "a nation of shop keepers."

We have heard something of an overproduction of scholars. There may be an overproduction of those who claim the preroga

tives of the scholar—there have always been honest, uninspired prophets—but of real scholars and prophets there can be no surplus. The race is to-day with Truth much as was Europe with its geography after the discovery of America. We have evidence of vast unexplored realms lying just beyond our ken, beckoning for our exploring intelligence. Just what they will turn out to be no one can say. Wild rumors are afloat. No doubt we may expect cargoes of glittering sand labeled gold. Fountains of youth will be located and Arabian marvels reported. It is most probable, however, that this new world will prove to be merely an enlargement of the old, offering additional chances for worthy, industrious people to live nobler and happier lives. But if so, that is no reason why this vast unknown should not be discovered, subdued and possessed. Indeed, is not America to-day (saying nothing of the future) more than if it had turned out a huge mountain of gold, encircled by fountains of immortal youth? But exploring parties must be fitted out, protected and supported; and after them the immigrant, and then the flood tide of civilization in all its complexity and richness. Children will be born and grow up in this new province and will never understand it. They will not realize that it has not always been so. Sad, indeed, will it be if they form a contempt for the old homestead of their parents "back east." And in this march of humanity through the ages, may the pillars of cloud and of fire never drop below the horizon leaving the race to grope blindly and madly about in a universal wilderness.

Such being the scholar and his position in society let us now pass to the consideration of the proper attitude of the state towards him. The true function of the state being to do all it can for the promotion of the general welfare of that portion of society embraced within its borders, there are at least four explicit obligations resting upon it in its relations with the scholar. The first of these refers to the material conditions of his existence; the second to the facilities for the prosecution of his duties as a scholar; the third to the state's appreciation of his distinctive work, and the opportunities it should afford him for performing this work; and the last to the great Platonic principle of justice—that of being let alone.

It is a common modern saying that every man has a right to live and, therefore, to the means of living, and that the state owes it to the individual to see that such provision is made for him. It is a very doubtful proposition if not clearly false. However that may be, it must be granted that if there be such an obligation resting upon the state to care for its individual members, the rights of

all men who are inoffensive are equal. Then the scholar could neither receive nor expect from the state any more attention than the artist, the artisan, the farmer, the merchant, the manual laborer, or the idler. If his case is in any manner peculiar, that fact must grow out of his peculiar relation to the state and the society which he serves. His characteristic function, and not his humanity, must determine the state's consideration of him. In other words, the state, in serving its own limited society and the larger society embracing the race, existent and prospective, must count the scholar as a mere means and treat him as such. While, of course, not forgetting that he is a man, the state is bound to use him to the extent and in the manner of his greatest usefulness. If he is useless, if he can do nothing for mankind, if he has nothing to give it, though all the wisdom of the ancients and moderns be his, the state has no interest in him and must drop him. The mere possession of scholarship as such shall avail him nothing—indeed, it is vanity.

But it has already been sufficiently indicated that the scholar has a peculiar function in virtue of his powers and profession. In truth, it must be admitted that his is one of the most essential of all the functions of the members of society. Growing out of his office, his service, his value measured in ideal welfare and progress of mankind, what can be said to be the duties of the state to the scholar as a scholar?

When Socrates had been condemned and the decision of the character of his punishment was pending, he was asked to suggest what should be done to him. Unabashed and unterrified, and in view of his service to the Greek people he asserted that he ought to be fed for the remainder of his life at the Prytaneum. In that case (and it does not stand alone) injustice was more powerful than justice and he was executed; but the world has said that even in this climax of his audacity he was right. Replying to our question, it may be said in the first place, that the scholar has a right to live and to the means of living. A very ambiguous proposition, it is true, but definiteness must depend upon the special features of the individual case. It is the old question of a competent wage for a competent service. We may amend the previous formula by saying that the state is obliged to provide for the scholar such means of living as it can afford, and as will at the same time be most conducive to his scholastic usefulness. The largest amount of the best quality of that which he only can produce and which society so much needs is the real end sought. The provision made

for the scholar by the state may be anything from chains to luxury, just so the greatest possible good will come of it. In a general way, however, it may be said that he and those dependent upon him should be provided with the ordinary comforts of the society of which they are members. In this he should, by all means, be allowed to feel safe. His scholarly office will certainly suffer extravagantly when he has to be embarrassed by the struggle for existence; and he must be permitted in safety to drift inevitably into a state of financial incompetency wherein he will no longer be capable of holding his own in an ever changing economic situation. His greatest usefulness cannot be obtained for a less price, and since that is essential, it is a good bargain.

Secondly, the scholar must be provided with the facilities necessary for the pursuit of his studies. If he is so fortunate as to be able to provide them for himself, from his own fortune or ingenuity, he will probably be better supplied than otherwise, he will avoid the humiliation of having to ask in vain, as did Columbus, and the people will be lucky. But this is seldom possible. The scholar is ordinarily poorly supplied with this world's goods and the means of getting the same. There have been notable exceptions, but their rarity makes them notable. Some of the attempts of the scholar to equip himself, or work without equipment, would make sad stories and result in the enlargement of the world's list of martyrs; and the failure and loss for want of such necessities can never be estimated. One of the greatest scholars of the century has but recently completed a task upon which he has been laboring heroically for half a century, and during all that long period he has been in almost constant need. It has been a struggle for opportunities to work as well as with the difficulties of his task. Herbert Spencer will have a monument some day- after he is gone. One cannot help recalling those magnificent equipments which are alleged to have been provided by the barbarian Alexander the Conqueror for that prince of scholars, Aristotle.

More frequently such material support must come from the few who have property but no talent, and who yet appreciate the work of the scholar. Private endowment of scholastic enterprises is one of the most interesting features of our modern society. Universities, technical and other schools, scientific museums, art collections and libraries—the scholar's instruments and products - are now provided more by such private munificence than by any other means. No estimate of what society thus owes to individual generosity can ever be made; and much more might and ought to be

done to encourage this most profitable of giving. There is much more money available for such purposes than is usually supposed or ever actually appears, if only the proper occasion were presented to the owners of wealth. But the state must not forget that such probable benefactors will expect, and have a right to expect, a permanently safe investment. All honor to him who gives what he can, much or little, that the race's wealth of knowledge may be enlarged.

Yet the arguments for this private giving are not all on one side. It has its objectionable features. Few men who can make money and give it, can refrain from placing restrictions about its use which rob it of much of its value. I am reminded of the remark of a friend, an instructor in psychology connected with an institution founded and supported by a certain Mr. Blank, a wealthy gentleman then living. When my friend showed me through room after room full of the finest and most appropriate apparatus, such as make the heart of the psychologist glad, I could not refrain from exclaiming, "You have everything—this is paradise—here you must be happy." "Yes," he replied, "and I suppose we would be if only Mr. Blank were dead." Experience shows, however, that the personal interest of those able to give cannot be relied upon to furnish the entire equipment of the scholar. For this reason and others the state must be appealed to. The limitation upon the proper functions of the state is the perennial political problem. Shall it undertake to supply the scholar as he has been described? When we remember other things the state does without criticism, and consider the scholar's important function in society which the state serves, the answer must be affirmative. Indeed it has been doing so for a long time. All of the modern civilized states have been backing the scholar in much of his work. I do not refer to the maintenance of the common schools and such measures as can be construed as protective to the state, but to such as aim to further the discovery and dissemination of Truth as such. The chief glory of Germany is not her splendid army but her magnificent universities, and she is followed closely by the other great nations of Europe. The federal government has made large land grants for colleges and universities, maintains a bureau of Ethnology, conducts the Smithsonian Institution, which is declared by law to be established for the "increase and diffusion of knowledge among men," and has almost committed itself to the establishment of a national university. The various states of the Union have done more or less along the same lines, the rule being that the newer

states, feeling the need of the scholar and his influence, and recognizing that no other provision can be made for him, have founded colleges where research and education can be carried on together. And why should they not? Certainly it is the business of the state to do all it can do and do well and safely for the people. Of course it must first protect life, liberty and property as these are conditions of all other forms of welfare of the people. But they are only means in the acquisition of other greater, and more ultimate goods, and if these more truly inherently desirable ends can be provided directly and in larger measure by the state, certainly it would be derelict in its duty if it failed to take the necessary action. The state, either by appropriation, exemption from taxation or similar measures favors the religious culture of the people. It can more safely go farther in the intellectual culture. In religion it has been found desirable for the state to do less than it did formerly. It may prove so in intellectual culture. It is conceivable that private endowment shall become so fully adequate and so unobjectionable in character as to absolve the state from its obligations. Yet fully adequate private endowment is not probable in the near future, and endowment entirely unobjectionable in character seems hardly more so. Private endowment with arbitrary conditions has already, in some old communities, proven offensive, worthless, or dangerous. An example of endowment with such unfortunate limitations is found in a great American educational institution, with property worth more than twelve million dollars, upon the premises of which no minister or other ecclesiastical representative is allowed to enter. Between private endowment cumbered with ill-advised or even whimsical restrictions, and state support wherein the politician's private, and it may be malicious, ends must first be subserved, the impecunious though devoted scholar hardly knows which way to turn. Is he to be blamed if he trims a little, if he wavers from the pursuit of his ideal end? As a scholar, yes—but he is human. His profession and his art will, nevertheless, have been degraded and the mere location of blame is then a question of slight importance. But these evils are not necessary. Much of private endowment is without any, or without serious restriction, and the state has issued warrants for the scholar's supplies which were not made returnable to some self-seeking politician. And it can and must be so in the future. There are enough intelligent citizens who so love their state, are so anxious about the fate of society, and so devoted to the cause of the Truth that they will force the politician to loosen his clutch upon such appropriations

and permit them to be used solely for their legitimate purposes.

After the state has made it possible for the scholar to live in such a way as to make him most useful, and has equipped him with the necessities of his profession, it can do much towards giving him the opportunity to serve society with his peculiar powers. In some things it has complete control of the situation. In others it is helpless. The state has assumed a certain authority over a number of the professions which are supposed to require some degree of scholastic attainment.

The business of common education has been almost entirely adopted into the legitimate functions of the state; and the state has established certain standards of scholarship as a condition of entering its service in this capacity. The charge of the pulpit has been assigned to voluntary associations because it has been found that society will be best served in this way; nevertheless the state can well afford to encourage superior scholarship in the pulpit—and it does it.

About the same can be said of the press, although I suspect that we are inclined to wish that the state might do more. The press is such a constant and powerful though insidious force in moulding the ideas and character of the people, and it is so frequently what it ought not be for that purpose, that the need of a reform is very generally manifest. But it is not clear that the state can do anything except to maintain the means for making scholars and trust to the good sense of the people to read after them rather than after the ignorant and incompetent scribblers to be found in the profession. It ought to be said in the face of certain contradition that this policy has resulted in a very marked improvement in the American press in recent years. The French practice of the state subsidizing the press is too dangerous to be considered, and the censorship of the press is not to be thought of.

The health and lives of the people are so obviously valuable that the state has undertaken to require some degree of scholarship in those who would practice medicine within its borders; but that its restrictions are usually inadequate is apparent to all. Our own state, it is said, was saved by accident from passing a law controlling shaving and hair-cutting, more exacting in its provisions than the law governing the practice of medicine. So, too, are liberty and property so sacred that, besides the maintenance of impartial courts, the state demands a minimum amount of legal knowledge in those who would become attorneys. Whether more ought to be required the profession itself will have to say.

But in the administration of the government itself there is abundant need for the skill and intelligence of a high order, such as are to be secured only by severe scholastic training. Of the three divisions, legislative, administrative and judicial, the judicial, from the beginning, has been in the most competent hands, in the national and state governments. The judges of America have been scholars. I suppose the reason for it is the evident necessity of professional learning to enable a man to sit on the bench at all; but beyond that there has been the popular feeling that as the courts were the last resort in the protection of popular rights they, at least, were to be preserved at their very best. Let us be thankful that it is so and hope it may continue so.

The instinctive desire to rule, so common among men, especially of a low order, together with the peculiar advantages accruing to the holder of office in the executive branch of government, have thrown that branch largely into the hands of the ambitious incompetent, whose scholastic qualifications have been lamentably deficient. It might have been expected that the waste of all sorts and the deterioration of the public service would continue until it would become unendurable and systematic measures be taken to put the service upon a respectable useful basis. This meant that some actual fitness, some preparation, that is to say, some scholarship should be required as a condition of admission to the service. And so we had the civil service reform movement which, for years, has been steadily gaining in favor and power in the national government and more recently has been adopted by some of the greater states. It should not be forgotten that this was a scholastic movement. It was first suggested by the scholar; it was defended and proven desirable and necessary by the scholar; it was with the greatest difficulty forced upon the army of self-seeking politicians by the scholar, and it is being administered by the scholar; and the outcome will be the admission of the scholar, the intelligently competent man, into the more important places in the state. There is no denying that the scholar in politics is a disturbing element not to be avoided by the ordinary means. He simply demands that the administration of affairs shall be entrusted to those who are best qualified to administer them. He is an unrelenting enemy of all who would thrive at the expense of the people and by means of the government. Thus the state is at last being forced to do its duty to the scholar by allowing him to use his superior abilities in the service of society through the state itself. But this recognition is only partial. There has been little change in the state

governments and smaller communities, and we must be content with the most indifferent service there until the merit system is adopted throughout our entire administrative system. When the scholar has succeeded in reforming the service of the federal government, may we not hope that he will turn his attention to the states? And is not Kansas a state?

Apparently the legislative is the worst branch of the government. A popular tradition, dating from the origin of popular government, still insists that representation and not ability is the underlying principle of the modern state. So he who is a type of the people he is to represent—the mediocre man—is sent to the legislature with the results so well known. One of our own state senators, a man of good sense though holding quite radical views on many subjects, writing after the close of the recent session of the legislature affirmed that desirable legislation was out of the question under existing conditions. This, he said, was due to the fact that the legislature was largely made up of men devoid of legislative training and ability and with little or no knowledge of law and the principles of government, so that, with purest of motives, they easily fall victims to the villain of the lobby. I suspect there is some truth in the complaint, but I do not see how matters would be improved by the plan he suggests of submitting important measures to a popular vote. To think this is to place the legislator below the average citizen which is hardly just. No, what is wanted is a higher degree of intelligence, a better knowledge of the principles of legislation and government, and a more studious devotion to the welfare of society; in other words, there is need of the scholar in the halls of legislation, and the state had better be sending for him.

Another position in which the state appears inclined to utilize the scholar is in the adjudication of international differences by referring them to him to decide upon the relative merits of the claims made by the parties involved—arbitration, so called. The plan is worthy of all praise. Extravagant language can scarely be used in depicting the beneficent results to flow from such substitution of the intelligence of the scholar for the savage malice of the warrior. But, it is said, arbitration was defeated. No, it was not. The principle of arbitration was never in such high favor as at the present moment. There was not even a vote on arbitration. In executive session there was a division on the money question and a minority of the senate, representing a much more meagre minority of the people of America, postponed one plan for arbitration,

largely because they hated the man who proposed it. And now we hear rumors of commissions of especially competent men—scholars, that is—for the disposition of the finance question, and even the tariff. Why, it is enough to suggest the dream of Plato.

These are some of the ways in which the state may recognize the superior ability of the scholar and put him to work for its own master—society. It must still be admitted that the scholar's chief sphere of usefulness will lie outside of the affairs of state, as has been already indicated; nevertheless the state may and ought to render him the greatest aid in discharging such duties.

The last among the duties of the state to the scholar that I care to name is at once the least and the greatest of the four, though merely negative. It is the simple recognition of the scholar's right of thinking according to the dictates of his own best judgment and of publishing his thoughts. A plea for the freedom of thought may sound strange in the closing days of the nineteenth century, but there is occasion for it. Since our opinions are held to be true else we would discard them, we cannot but consider one who differs with us as being in error, and we have an instinctive antipathy for him. It will be little short of a miracle if we do him justice. The tolerance which comes from broad scholarship is all that can save us. So he who would profess a very novel view on any important question must expect to be misunderstood, maligned, execrated. It has ever been so and will not soon change. The truth has not been welcome and its bearer has been regarded as an enemy. Now if this is true on account of the very constitution of human nature, is it not in the province of the state, so far as it is possible, to protect the innocent and the beneficent, and for the same reason that it protects the body and property of the ordinary citizen, namely, because the welfare of society requires it? Certainly in no possible situation should the state itself turn persecutor. Of all members of the community the one most free from prejudice and personal interest and, therefore, most likely to be right will be the professional scholar—only, of course, in the lines of his scholarship. The wise state will, therefore, appoint him advisor instead of setting a censor over him. Forcible limitation of the scholar is worse than starving him or failing to provide straw for his bricks. The greatest and purest truths, and, therefore, the public good, are to be secured by retaining the finest, fairest, clearest minds, and then giving them white cards, without censure for failure or praise for success. And this the state can well afford to do—it ought to do.

In Curtis's oratorical masterpiece, "The Duty of the American

Scholar," occasioned by the destruction of the pioneer town of Lawrence, Kansas, which so stirred the best youth of America, he selected John Milton as his typical scholar, because, with all his great learning, he readily gave himself to the service of the state in the administration of its affairs at a critical moment. For our purposes we may choose the same name but for another reason. I am not sure that I am right, but I confess that to me Milton has always seemed greatest not in official life, nor in poetry—even Paradise Lost, but in the Areopagitica. There is no grander plea for a nobler end than his appeal for the freedom of thought and speech. Listen to a sentence or two.

"If therefore ye be loath to dishearten utterly and discontent, not the mercenary crew of false pretenders to lerning, but the free and ingenuous sort of such as evidently were born to study, and love lerning for it self, not for lucre, or any other end, but the service of God and of truth, * * then know, that so far to distrust the judgement and the honesty of one who hath but a common repute in lerning, and never yet offended, as not to count him fit to print his mind without a tutor and examiner, lest he should drop a scism, or something of corruption, is the greatest displeasure and indignity to a free and knowing spirit that can be put upon him. * * * When a man writes to the world, he summons up all his reason and deliberation to assist him; he searches, meditats, is industrious, and likely consults and conferrs with his judicious friends; after all which done he takes himself to be inform'd in what he writes, as well as they that writ before him; if in this the most consummat act of his fidelity and ripenesse, no years, no industry, no former proof of his abilities can bring him to that state of maturity, as not to be still mistrusted and suspected, unlesse he carry all his considerat diligence, all his midnight watchings, and expense of Palladian oyl, to the hasty view of an unleasur'd licencer, perhaps much his younger, perhaps far his inferiour in judgement, perhaps one who never knew the labour of book writing, and if he be not repulst, or slighted, must appear in Print like a punie with his guardian, and his censors hand on the back of his title to be his bayl and surety, that he is no idiot, or seducer, it cannot be but a dishonor and a derogation to the author, to the book, to the priviledge and dignity of lerning. * * And how can a man teach with autority, which is the life of teaching, how can he be a Doctor in his book as he ought to be, or else had better be silent, whenas all he teaches, all he delivers, is but under the tuition, under the correction of his patriarchal licencer to blot

or alter what precisely accords not with the hide-bound humor which he calls his judgement. When every acute reader upon the first sight of a pedantick licence, will be ready with these like words to ding the book a coits distance from him, 'I hate a pupil teacher, I endure not an instructer that comes to me under the wardship of an overseeing fist. I know nothing of the licencer, but that I have his own hand here for his arrogance; who shall warrant me his judgement?' The State Sir, replies the Stationer, but has a quick return, 'The State shall be my governours but not my criticks; they may be mistak'n in the choice of a licencer as easily as this licencer may be mistak'n in an author: This is some common stuffe;' and he might adde from Sir Francis Bacon, That such authoriz'd books are but the language of the times. For though a licencer should happ'n to be judicious more than ordnary, which will be a great jeopardy of the next succession, yet his very office, and his commission enjoyns him to let passe nothing but what is vulgarly receiv'd already. * * Yet if these things be not resented seriously and timely by them who have the remedy in their power, but that such iron moulds as these shall have autority to knaw out the choisest periods of exquisitest books, and to commit such a treacherous fraud against the orphan remainders of worthiest men after death, the more sorrow will belong to that haples race of men, whose misfortune it is to have understanding. Henceforth let no man care to learn, or care to be more than worldly wise: for certainly in higher matters to be ignorant and slothfull, to be a common stedfast dunce will be the only pleasant life, and only in request."

Words written two and a half centuries ago. And they sound old. The spelling and phrasing are antique. The thought of licensing the press seemed as a nightmare of the race, so barbarous was it. But who will say that the real theme, the untrammeled freedom of the scholar to think and teach according to the dictates of his own best thoughts, is not yet a vital one? Let us say nothing of people as individuals for their intolerance of any teaching not consistent with their own ordinary views. That they are misinformed, narrow minded, and it may be, bigoted, is their misfortune, due, perhaps, to the illiberal, blundering policy of the state which educated them. But for the state, the guardian of the present and future welfare of all the people—the instrument of society in its development towards its noblest ideals—for the state wilfully to place arbitrary bounds upon the highest intelligence of its citizens, is a blunder which is worse than a crime. The only

safety of a people who aspire to anything above the commonest mediocrity lies in the absolute freedom of the teacher, from the primary grade to the university, to think and teach what he finds to be the truth, and an equal freedom for the student. And the people ought to know this. They ought to so understand the function of the genuine scholar in a well ordered society that no circumstance would lead them to hesitate in denouncing any attempt of those who represent them in the government thus to abridge the rights of intelligence. But if this cannot be, then "Henceforth let no man care to learn, or care to be more than worldly wise; for certainly in higher matters to be ignorant and slothfull, to be a common stedfast dunce will be the only pleasant life, and only in request."

These, then, are the duties of the state to the scholar because of his usefulness to society in its efforts to attain its highest life:

First, he must be secure in such a degree of personal comfort as will make most certain his greatest usefulness.

Second, he must be supplied with all the materials and instruments that he can profitably employ in the performance of his duties.

Third, he must be given every possible opportunity to serve society in his capacity as a scholar.

Fourth, his emancipation must be guaranteed him irrevocably. No competent, righteous state will fail to discharge these duties promptly, fully, and with enthusiasm.

The Pronouns Used in Address in Lessing's Dramas.

BY EUGENE C. ALDER.

From the scanty material which remains to us out of the early literature of the German race, it seems evident that originally the second person singular Du was the only pronoun used by one person in addresing another. But by the beginning of the ninth century, influenced by the Roman and Byzantine style, as Grimm clearly shows, the second person plural Ihr, followed by a plural verb, began to appear in the address of subject to king. Gradually this use became general in courtly forms and by the thirteenth century Ihr had, in many cases, taken the place of the singular Du. Parents continued to use Du to their children but, in return, received Ihr from them. The influence of the Ihr had not yet reached the common people but in the conversation of the nobility Du had almost disappeared. Lovers to each other and suitors were accustomed to use Ihr, although the change to Du was easily made; while the general address of the inferior to his superior was now almost always Ihr.

From the thirteenth century to the seventeenth few changes took place and with the exception that kings and persons of high rank were given the titles: Majestät, Fürstliche Gnaden, etc., the modes of address remained practically the same. Out of this last courtesy toward the royalty, however, there developed a pronoun of address, which, although now almost obsolete, had great influence during its comparatively short existence—the third person of the singular, masculine Er and feminine Sie. When the custom of addressing a person of high rank with simply a title, as "Mein Herr verzeih" or "Ist denn der Herr Bruder nicht verheirathet?" became well established, the apparently innate tendency to shorten and abbreviate caused the people to devise some shorter mode of address and since the verb, to agree with the title, had been in the third person of the singular, the third person singular of the pronoun began to be used.

When, in the second half of the sixteenth century, this usage of Er and Sie (singular) first became general, it was considered more polite than Ihr and immediately became the pronoun of the nobility—"Schönste Princessin, Sie wende das Auge nur auf mich:" "Wie, mein Elbenstein, will Er mir nicht diesen Gefallen erweisen?" The change did not rest here, however. The nobility soon became dissatisfied again and feeling that the mere title was not sufficient to express deep reverence and profound courtesy, particularly as the Er and Sie (singular) had, in the mean time, become too common for their use, they remedied the difficulty by combining the title with a plural verb of the third person -"Seine Durchlaucht, der Herzog, empfehlen sich my Lady zu Gnaden."—And finally, in the latter part of the seventeenth century, as in the case with Er and Sie (singular), the title was dropped and Sie, the third person of the plural, substituted. Thus, in general, summing up briefly the changes which took place in the pronoun up to the eighteenth century, we see that it was a "substitution successively of the second person plural for the second person singular, of the third singular for the second singular and of the third plural for the second person plural and singular."

As the first decades of the eighteenth century open to our view, the pronoun boundaries are still vacillating and uncertain. Du has long since withdrawn from the struggle and, contented with what it possesses, expresses only relationships of the greatest familiarity. The third person singulars Er and Sie continue to maintain their rank above their older rival Ihr, while the third person plural Sie has gradually become the pronoun of polite address, but it is not until 1750 that these uses become well established.

Jacob Grimm, in referring to the third person plural Sie, calls it "a trespass upon sense and taste." From a grammatical point of view, to be sure, the pronoun Sie can not be defended, but if it adds strength and power to the language, this one drawback is certainly counterbalanced. If the pronouns, Du, Ihr, Er and Sie, each have their distinct and separate fields of expression, if the delicate shades of relationship can be better described, if the psychological changes of feeling can be better shown, and if, as would be inferred from the statements of standard dictionaries and grammars, there are definite rules governing the use of these pronouns, we would agree with Bernhardt that "in itself, diversity of address is no disadvantage." On the other hand, if in the best literature of the race, if in the usage of the best German authors we should find evident confusion and unexplainable exception to

many of the so-called rules, if in the very changes themselves we could find no apparent reason or motive for the same, we would be compelled to agree with Grimm and bemoan the multiplicity of the German pronoun forms.

In order to throw brighter light on the question, a careful study of the pronouns as found in Lessing has been made with this in view and the uses, as far as possible, formulated. The classification has been based upon familiarity - the familiarity of intimacy, between equals, as between husband and wife, etc.,—the familiarity toward inferior age or station as father to child, master to servant, etc., and yet, in many places, this formulation will be found unsatisfactory, due to the doubtful and compound relationships—(in Emilia Galotti Emilia to Prince; in Nathan der Weise—Recha and Templar) which abound in Lessing's works. On the other hand, an attempt to make a classification upon psychological grounds, dividing the uses of the pronoun under heads of entreaty, coolness, anger, etc., while perhaps possible, would of necessity be more complicated.

In the following formulation, the dramas enumerated under each heading contain examples of that particular pronoun-usage. In dramas italicised exceptions have been found. The material from which these generalizations are derived was printed in the April number of the QUARTERLY.

Du.

I. APOSTROPHE: Der Junge Gelehrte; Die Alte Jungfer; Damon; Der Misogyn; Der Freigeist; Der Schatz; Miss Sara Sampson; Philotas; Minna Von Barnhelm; *Emilia Galotti*, and Nathan der Weise.

Exceptions: Emilia Galotti, Prince to Claudia: Sie (33), Marinelli to Appiani: Sie (58).

II. PARENTS TO CHILDREN: *Der Junge Gelehrte; Der Misogyn;* Die Juden: Der Freigeist; Der Schatz; *Miss Sarah Sampson;* Emilia Galotti; Nathan der Weise.

Exceptions: Der Junge Gelehrte, Chrysander to Damis: (I, 2) "Bleib' Er mir, Herr Informator, mit den Possen weg!" and then "Den Augenblick schwur er, er kenne keine Frauenzimmer," also (III, 4) "He, Herr Doctor, vergess' Er nicht dass ich Vater bin!" Der Misogyn: Wumshäter to Laura, "Schweig' Sie doch!" (162) then Du and finally "Macht Ihr mich nicht blind." The last address may, perhaps, refer to the others present. Miss Sara Sampson, Mellefont to Arabella: Sie (206).

III. MASTERS, MISTRESSES, OR MEMBERS OF THE FAMILY TO SERVANTS, EXCLUSIVE OF RANK (see Du VII): *Der Junge Gelehrte;* Die Alte Jungfer: Damon: Der Misogyn: *Der Freigeist; Der Schatz;* Miss Sara Sampson; Minna von Barnhelm: *Emilia Galotti,* and Nathan der Weise.

Exceptions: Der Junge Gelehrte, Damis to Anton: "Will Er mich länger stören?" Damis to Lisette: Sie (sing. 3 person). Der Freigeist, Lisidor to Johann: "Kann der Schurke nicht näher kommen?" Der Schatz, Anselmo to Maskarill (before recognizing him): Ihr (103). Lelio to Maskarill: Du (92), but Lelio to Maskarill (suspecting him of theft): "Sie haben Ihre Hand" (92). Emilia Galotti, Claudia to Pirro: Ihr (41). Prince to Kammerdiener: Ihr (27). Die Juden, Krumm to Lisette: Sie. Krumm to Lisette: Sie (3d sing.). Jew Traveler to Servant: Ihr.

IV. ADDRESS TO THE DIETY: (See Du I.)

V. LYRIC POETRY, IDEALISTIC SUBJECTS, EXALTED VERSE. Philotas.

VI. HUSBAND AND WIFE, BROTHER AND SISTER, AND RELATIONSHIPS WHICH PRESUPPOSE INTIMACY, EXCEPTING CHILD TO PARENT (see Ihr I, Sie I) AND LOVERS TO EACH OTHER (see Ihr III, Sie III): *Die Alte Jungfer; Der Misogyn; Der Freigeist;* Der Schatz; *Miss Sara Sampson;* Minna von Barnhelm: *Emilia Galotti,* and *Nathan der Weise.*

Exceptions: Die Alte Jungfer, Lelio to Ohldinn (see Sie VI). Der Misogyn, Valer to Laura: Ihr (144), perhaps speaking generally. Der Freigeist, Theophan to Araspe and vice versa (Sie VI). Miss Sara Sampson, Mellefont to Marwood and vice versa: Sie (showing estrangement), but Mellefont to Marwood (angry): Du (207). Mellefont to Marwood (taking dagger away): Du (208). Marwood to Mellefont (confidentally): Du (197). Marwood to Mellefont (angry): Du (206 and 207). Emilia Galotti, Claudia to Odoardo: Sie (40). Prince to Orsina (showing estrangement): Sie (see Sie VII). Nathan der Weise, Templar and Recha (see Ihr III). Damon, Damon to Oronte: Sie. Oronte to Damon: Er.

VII. HIGHER IN RANK TO LOWER: A. Royalty (see Sie VII and Du VIII): B. Master and mistress to servants (see Du III); C. Others: (also see Er I): *Der Junge Gelehrte;* Die Alte Jungfer; Die Juden; Der Schatz; Philotas (Du V); Minna von Barnhelm (Ex. Sie VI): Emilia Galotti: Nathan der Weise.

Exceptions: Der Junge Gelehrte, Valer to Anton: Sie.

VIII. ROYALTY TO NOBILITY, OFFICIALS AND FREE SUBJECTS: Nathan der Weise.

Exceptions (see Sie VII).

IX. COMMONERS TO NOBILITY AND ROYALTY: Nathan der Weise.

Exceptions (see Sie VIII).

X. CONVERSATION OF THE LOWER CLASSES: A. Servants to servants (see Er III); B. Others: Emilia Galotti; Die Alte Jungfer; Die Juden; *Minna von Barnhelm.*

Exceptions: Minna von Barnhelm, Franziska to Werner: Er (59) (see Sie III). Franziska to Werner: Sie (66). Franziska to Werner: Er (69). Franziska to Werner: Sie (84). Franziska to Werner: Er (122).

Ihr.

I. CHILDREN TO PARENTS AND GUARDIANS: Nathan der Weise.

Exceptions (see Sie, I).

II. SERVANTS TO MASTERS, MISTRESSES AND THOSE ABOVE THEM IN RANK: *Nathan der Weise.*

Exceptions (see Sie II): Nathan der Weise, Daja to Templar: "So geh, du deutscher Bär." Here, however, the Templar may be supposed to have already left the stage. Daja to Recha: Du (23, sc. III.)

III. LOVERS TO EACH OTHER: Nathan der Weise (see Du VI).

Exceptions (see Sie III).

IV. STRANGERS TO STRANGERS: *Nathan der Weise; Die Alte Jungfer; Die Juden. Der Schatz.*

Exceptions: Nathan der Weise, Templar to Daja: Du (III, 109). Die Alte Jungfer, Peter (as v. Schlag) to Rehfuss: "Lass' Er sich um die Bezahlung nicht bang sein." Die Juden, (see Sie IV) also Er IV. Der Schatz (see A and B, Sie IV).

V. YOUTH TO AGE, EXCLUSIVE OF ALL SPECIAL RELATIONSHIPS: Nathan der Weise.

Exceptions (see Sie V).

VI. FRIENDS AND ACQUAINTANCES: A. Servants (see Er III); B. Others; B. —— (see Sie VI): *Nathan der Weise.*

Exceptions: Nathan der Weise. Nathan to Dervish (see Du VII).

VII. THOSE OF HIGH RANK TO STRANGE SERVANTS: Die Alte Jungfer; *Die Juden;* Der Schatz; *Damon;* Minna von Barnhelm.

Exceptions: Die Juden, Baron's Daughter to Christopher (see Er III). Baron's Daughter to Lisette (see Du VII). Baron to Lisette (see Du VII). Damon, Leander to Lisette: Du (129). Damon to Lisette: Du (124). Der Junge Gelehrte, Valer to Lisette: Du. Valer to Anton: Sie. Emilia Galotti, Emilia to Battista: Er (60). Claudia to Battista: Du (64).

VIII. ROYAL PROCLAMATIONS, ETC: Minna von Barnhelm.

Er and Sie (singular).

I. IN POLITE ADDRESS FROM THOSE OF HIGHER TO THOSE OF INFERIOR RANK: *Die Alte Jungfer; Die Juden;* Der Misogyn; Der Freigeist; Minna von Barnhelm.

Exceptions (see Du VII): Die Alte Jungfer, Peter (disguised as v. Schlag) to Rehfuss: Ihr. Kräusel to Lisette: Sie. Die Juden, Baron to Christoph: Ihr (may be plural) (see Ihr VII).

II. GUARDIANS TO WARDS: Der Junge Gelehrte; *Der Schatz.*

Exceptions: Der Schatz, Philto to Lelio: Sie.

III. SERVANTS TO SERVANTS: *Der Junge Gelehrte; Die Juden* (see Ihr VII); *Der Freigeist;* Miss Sara Sampson; Minna von Barnhelm.

Exceptions (see Du X): Der Junge Gelehrte, Anton to Lisette: Du. Lisette to Anton: Du. Die Juden, Christopher to Lisette: Sie (pl.) (sc. 9 and 10). Christopher to Lisette: Sie (3d sing.) (sc. 14). Christopher to Lisette: Sie (pl.) (sc. 14). Christopher to Lisette: Sie (3d sing.) (19, 20, 23). Lisette to Christopher: Sie (pl.). Lisette to Christopher: Er (sc. 20, 23). Der Freigeist, Martin to Johann: Du. Johann to Martin: Du. Lisette to Martin: Du.

IV. TO HIGHER TRADESMEN, OFFICIALS AND TAVERNKEEPERS: Die Alte Jungfer; *Die Juden; Miss Sara Sampson; Minna von Barnhelm.*

Exceptions: Die Juden, Traveler to Krumm: Ihr (see Ihr IV). Baron's Daughter to Krumm: Er. Baron's Daughter to Krumm: Ihr. Lisette to Krumm: Er. Lisette to Krumm: Sie. Miss Sara Sampson, Waitwell to Wirth: Du (179). Minna von Barnhelm, Tellheim to Wirth: Sie. Minna to Wirth: Sie. Franziska to Wirth: Sie (30). Just to Wirth (in sleep): Du. Just to Wirth (awake): Er.

Sie.

I. CHILDREN TO PARENTS AND GUARDIANS: Der Junge Gelehrte, Der Misogyn; Die Juden; *Der Freigeist;* Der Schatz; *Miss Sara Sampson;* Minna von Barnhelm; Emilia Galotti.

Exceptions: Der Freigeist, Lisidor to Philane—Göschen ed. has 5, 6 near end: "Mama, ich glaube Sie werde," etc., followed shortly by "Kommen Sie." Hempl. prints in this place, "Sie werden." Miss Sara Sampson, Miss Sara Sampson (delirious) to Sir William (263): "Segne mich, wer du auch bist." Nathan der Weise (see Ihr I).

II. SERVANTS TO MASTERS, MISTRESSES AND THOSE ABOVE THEM IN

RANK: Der Junge Gelehrte; *Die Alte Jungfer;* Damon; Der Misogyn; Die Juden; Der Freigeist; *Der Schatz;* Miss Sara Sampson; Minna von Barnhelm; Emilia Galotti.

Exceptions: Die Alte Jungfer, Lisette to Peter (as v Schlag) aside: Du (III, 6). Lisette to Peter (as v. Schlag,) angry: "Was will Er, mein Herr?" Lisette to Kräusel: "Du verdammter Hundsfott." Peter (as cake peddler) to Kräusel: Du. Der Schatz, Maskarill to Anselmo (117): "Ach, unglücklicher Vater, was wirst du zu dieser Nachricht sagen." Nathan der Weise (see Ihr II). Philotas, Soldier to Philotas (see Du V).

III. LOVERS TO EACH OTHER AND SUITORS: Der Junge Gelehrte; *Die Alte Jungfer;* Damon; Der Misogyn; Der Freigeist; Miss Sara Sampson; Emilia Galotti; *Minna von Barnhelm.*

Exceptions: Die Alte Jungfer, Peter (as v. Schlag) to Ohldinn (III, 6): "Wäre Sie schon meine Frau," etc. Peter (as v. Schlag) to Ohldinn: "Nicht wahr, meine liebe Frau, du willst es bezahlen?" Minna von Barnhelm, Minna to Tellheim (45): "Deine Hand, lieber Bettler." Franziska to Werner and vice versa (see Du X). Nathan der Weise (see Ihr III).

IV. STRANGERS TO STRANGERS—SUPPOSEDLY EQUALS: *Die Alte Jungfer;* Der Misogyn; *Der Schatz; Die Juden;* Der Freigeist; Miss Sara Sampson; *Minna von Barnhelm; Emilia Galotti.*

Exceptions: Die Alte Jungfer, Klitander to v. Schlag: Du. Der Schatz, A. Anselmo to Raps: Sie, but (112) suspecting him of fraud Ihr, and finally (112) Du. B. Raps to Anselmo: Ihr, then Sie (106) without apparent reason for the change, next Du and then back to Sie, finally, however, ending with "Ich will dir schon Einen schicken" (112). Die Juden, Jew to Krumm (see Ihr IV). Minna von Barnhelm, C. Count of Bruchsall (120): "Wenn dein Mund nicht plaudern kann, so kann dein Herz doch reden." D. Just to strange servant (see Er III). E. Werner to Franziska and vice versa (see Du X, B). Emilia Galotti, Odoardo to Orsina (80): "Liebes Kind, wer wieder sagt, dass du eine Närrin bist," etc. Nathan der Weise (see Ihr IV).

V. YOUTH TO AGE EXCLUSIVE OF RANK AND RELATIONSHIP: Der Schatz; Der Freigeist; Der Misogyn; Emilia Galotti; Miss Sara Sampson.

Exceptions: Nathan der Weise (see Ihr V).

VI. FRIENDS AND ACQUAINTANCES: A. Servants (see Er III); B. Others; B. —— (see Ihr VI): Der Junge Gelehrte; *Die Alte Jungfer;* Damon; Der Misogyn; Der Schatz; *Der Freigeist;* Emilia Galotti; *Miss Sara Sampson.*

Exceptions: Die Alte Jungfer, Klitander to Lelio: Du. Der Freigeist, Lisidor to Adrast: Sie (1st speecn, sc. III). Lisidor to Adrast: Er (next speech). Lisidor to Adrast: Du. Lisidor to Adrast: Er ("Euch, Ihn und Theophan"). Lisidor to Adrast: Sie, and finally, Lisidor to Adrast: Er. Next, Lisidor to Adrast: Sie (sc. 4), (act V, sc. v). Then, Lisidor to Adrast: Du (V, 6). Miss Sara Sampson, Sir William to Mellefont (267) Du. Minna von Barnhelm, Major to Werner (see Du VII). Nathan der Weise (see Ihr VI).

VII. ROYALTY TO NOBILITY, OFFICERS AND FREE SUBJECTS: *Emilia Galotti.*

Exceptions: Emilia Galotti, Prince to Marinelli (33): Sie, but Prince to Marinelli (angry) (35): Er. Prince to Marinelli (rage) (36) Du. Prince to Marinelli (94): Du. Prince to Orsina (see Du VI). Nathan der Weise (see Du VIII). Philotas (see Du V).

VIII. COMMONERS TO NOBILITY AND ROYALTY: *Emilia Galotti.*

Exoeptions: Emilia Galotti, Claudia to Marinelli (64): Sie, but Claudia to Marinelli (65): Du. Claudia to Marinelli (66): Sie. Claudia to Marinelli (66): Du. Marinelli to Prince (33): Sie, but Marinelli to Prince (69): Er. Marinelli to Prince (69): Sie. Orsina to Marinelli (71): Sie, but Orsina to Marinelli (73): Du. Orsina to Marinelli (73): Sie. Nathan der Weise (see Du IX). Philotas (see Du V).

As a conclusion to the foregoing formulation, a summary of the different pronoun-uses will hardly be necessary. In most cases the general headings here correspond to those given by Grimm in his "Deutsches Wörterbuch." Concerning the exceptions, however, more may be said.

In attempting a compilation of this nature, a concise well-outlined formulation is difficult. In many cases division lines will be found vague and indistinct; exceptions to one heading will prove favorable evidence to another, and yet, eliminating, as far as possible, all these drawbacks and hindrances, hardly one of these headings is free from exception and apparently unexplainable inconsistency. How to account for these variations is the puzzling question.

We find Du (see Du I) used continually in Apostrophe, yet, without any apparent reason on the part of the author for the change, the prince is made to exclaim to the absent mother of Emilia "Was Sie dafür wollen, ehrliche Mutter! Fodert nur!" and Marinelli, as he hears the distant gun-shots at the murder of the Count, cries out "Ha, Herr Graf, der Sie nicht nach Massa wollten," etc.

The use of Du by parent to child, by master to servant, by husband and wife, is, in all cases, frequently disregarded. Sie, in the conversation of child to parent, servant to master, lovers to each other, is sometimes laid aside for the more formal Er, or the less formal Du, as the case may be—this, however, without any apparent change in feeling, demanding such variation. While the uses of Er and Sie (singular) are inextricably confused with Ihr, on the one hand, and Du on the other.

Some of these exceptions may be explained by psychological changes in the attitude of one speaker to the other, yet this, in itself, will not begin to cover all cases, and certainly not such examples as the conversation between Raps and Anselmo (see Sie IV, A and B) and that of Lisidor to Adrast (see Sie VI, Der Freigeist). If Grimm's justification of Nathan's Du toward the Sultan, on the grounds of a "Gefühl des eigenen Werthes," is valid, may we attempt a vindication of the Templar's Du upon a similar basis?

To account for these exceptions to the established rules we have at least three options. Either Lessing through sheer carelessness allowed these incongruities to slip into his works, or he was unacquainted with the then prevailing pronoun-uses, or we, without sufficient grounds, have maintained that usage has been far more uniform than it really has been. However, until investigations, similar to the one above, have been made in the works of other German authors, this question cannot be definitely settled.

Editorial Notes.

Mr. Barnum Brown, at present in the employ of the American Museum of Natural History, has assisted in taking out some rarely complete dinosaur skeletons near Laramie, Wyoming.

Associate Professor W. C. Stevens has spent the summer semester in the laboratory of Professor Strassburger, at Bonn, and will return to his work at the University of Kansas in September.

Dr. W. S. Franklin, University of Kansas, '87, for some years professor of physics in the Iowa Agricultural College, Ames, Iowa, has been appointed to the chair of physics in Lehigh University, Bethlehem, Pennsylvania.

Associate Professor E. C. Franklin, who spent the first half of 1897 in Costa Rica as an expert assayer, has declined a financially very tempting offer to continue in that work, and will resume his position in the University of Kansas.

The second number of the *Journal of Germanic Philology*, edited by Gustaf E. Karsten of the University of Indiana, contains seven chief articles and six careful reviews. The character of the work is very high, and must tell greatly for the standing of American scholarship.

The Fifth Book of Xenophon's Anabasis, edited by Alfred G. Rolfe (Ginn & Co.) is an admirable little volume for its purpose—that of rapid sight reading, being equipped with notes, a complete vocabulary, and synoptical headlines for the paragraphs. There is also a good map.

Mr. A. T. Walker, University of the City of New York, '87, has been elected to the chair of Latin Language and Literature recently vacated by Professor D. H. Holmes. Mr. Walker has taught in Vanderbilt University and the Emory and Henry College, and resigns a position as instructor in the University of Chicago to come to the University of Kansas.

Mr. William B. Cairns's "The Forms of Discourse" (Ginn & Company) will hardly impress the teachers of rhetoric in our best high schools and colleges as being so novel in its fundamental conception as the author seems to imagine it. That "the study of style should be carried on simultaneously with that of invention" (preface, p. 4) is no novelty to the teacher of rhetoric who knows his business, although teachers of the grade of rhetoric Mr. Cairns seems to have prepared his book for will probably find that he has diminished its value for their work by laying too little emphasis upon style, and too much upon invention. Nevertheless, Mr. Cairns's handling of Narration and the other forms of discourse, is bright, careful and suggestive, and he has included in his book, for critical analysis by the student and illustration of the principles set forth in the text, many unhackneyed selections, most of them well chosen for his purpose. R. D. O.

Method in History for Teachers and Students, by William H. Mace, Professor of History in Syracuse University, 12 mo. 308 pp. Ginn & Company.

The key to this work is found in the statement in its preface that the specialist in his particular department, if he but turn his attention to method, would bridge

over the chasm between theory and practice for he is better authority on "the problem of method in his field than the Professor of Methods or the Chair of Pedagogy." Acting upon this idea Professor Mace has worked out his methods from his own practical standpoint. The first part of the book is devoted to a discussion of the General Nature of History, which abounds in apt historical illustration. The principal subjects discussed are organization, interpretation and co-ordination. In this, as in other parts of the book, the analysis is somewhat strained. The second part of the book is a concrete review of American History under the title of Organization, Periods of American History in which the author successfully applies his theory. The third and last part of the book relates to elementary phases of history teaching in which the "sense phase" and the "representative phase" are dwelt upon to some length. The book, upon the whole, is a thoughtful presentation of the subject and one of the best of its kind. F. W. B.

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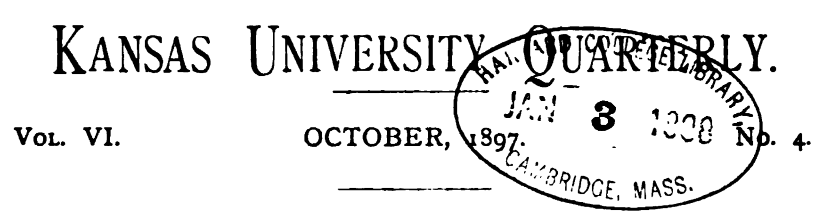
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Notes on Brief-Making.*

BY E. M. HOPKINS.

Parts of a Brief. A brief, the outline or skeleton of an argument to be presented, consists of three principal parts; the proposition to be proved, the introduction, and the brief proper. The first and third are essential; while the second in certain circumstances to be noted may be dispensed with, but not usually. There is also the conclusion, important in amplification, but less so in the brief.

Proposition to be proved. The making of a brief presupposes that the author of it intends to offer an argument, either in direct opposition to that of some one else, or in general support of some opinion which he holds, concerning the truth of which some doubt exists, or some question has been raised. As a rule, the subject of an argumentative discussion, especially when it is suggested by current events, as is likely to be true in what may be termed popular discussion, presents itself in the form of a question: such as, Is a certain principle or policy right or wrong? Is a certain event likely or not likely to happen? Is a certain course of action expedient? A general form which may be assumed to include all the others is: Is a certain statement or proposition true?

Source in a general question.

Thesis. But as a question cannot be proved or disproved, because it asserts nothing, it becomes immediately necessary to determine from the question, which may be carelessly framed, general, vague, or even meaningless when strictly exam-

*An incomplete general outline of a method of presenting the subject, using no more of formal logic than is necessary, which has proved effective in practical class work. Among the general sources from which suggestions have both obtained, the most direct acknowledgment is due to Baker's "Principles of Argumentation."

ined, a clear, concise assertion or declaration, as specific as possible, which may be made the subject of proof. This is usually designated the proposition to be proved; but as the term proposition applies also to each and all of the proofs, the term thesis or principal thesis (Sidgwick) will be used in this paper instead.

Phrasing. But simply to substitute a declaration for a question will not necessarily answer the purpose. It has already been stated that the statement of the point at issue must be clear, concise, and as specific as possible. Broadly defined, such a statement consists of a subject and an assertion concerning that subject; logically defined it consists of two terms and a copula, the verb *is*. In either form, the one reducible to the other, the essential is that the subject shall be a term, that is an expression which, however many modifications it may contain, however complex its structure may be, shall yet be the equivalent of a single idea; and that the predicate shall also express but a single idea concerning that subject. Regarded as a sentence, a thesis may not be either compound or complex; and as a working rule, every appearance of compoundness or complexity should be eliminated from it, from subject and predicate as well as from the statement as a whole.

Limiting. It does not yet follow that the statement is ready for discussion. Its terms may be so broad in their inclusion, or its application so extended, or its precise meaning so uncertain or ambiguous, that it may be impossible to find sufficient material to serve as proof of it, impracticable to discuss it within the available space and time, or difficult to bring any proofs to bear directly and unmistakably upon it, or to make any use of it after it is proved. The latter error usually arises from missing or misunderstanding the real point of the original question from which the statement is derived; and, of course, the real point may be missed when the resulting statement is perfectly clear. (See illustration p. 131.) In either case the only remedy is to substitute a new statement for the unsatisfactory one. The first two errors mentioned may be corrected by a process of division of the terms of the first statement made, taking a part or an individual of a class instead of an entire class; or by the equivalent process of limiting the application of those terms, as to a specified place or time, or to specified circumstances. As a result of this narrowing process, a brief-maker who intended at first to state that capital punishment is wrong, might content himself with stating that it was wrongly imposed in a certain instance, or that a certain mode of inflicting it is wrong, or inexpedient. The limiting of a statement is to a certain

extent instinctive, as the result of a natural caution about saying more than can easily be supported when the thought of having to support it is uppermost in the mind. But the brief-maker may not trust his instinct, but must see to it that he affirms no more than he can support with reasons, remembering that he is not now stating an opinion based, perhaps, upon inclination or the opinions of others, but a proposition which he must be prepared to defend, if need be, against organized attack. In debate this organized attack is expected, and is duly guarded against; but in general reasoning, a writer may, unless he takes pains not to do so, forget that his argument is not necessarily addressed only to those who will agree with it, and in consequence may weaken it at its foundation by too broad assertion.

Balancing. Some further concession to a possible opposition is also advisable. As intimated, if there is to be argument in support of a proposition, it is not only presupposed that the defender of it believes it to be true, but that there are a considerable number of others who do not believe it, or who believe that it is not true; that is, believe in its contradictory. Accordingly, if the limitation of the subject proposition is carried so far or made in such a way that the resulting proposition cannot be denied, it is, of course, no longer a subject for argument; defense of it is thereby rendered unnecessary. This probably means that in making the limitation, the central point of the original statement has been cut out; but while this must, of course, be avoided, the brief-maker must not only hold to the exact point at issue, but in fairness to those who do not agree with him should so state his proposition that by inserting a negative it will become a proposition which those others believe and are ready to defend. This means, as commonly stated, that the two sides of it shall be as nearly as possible equal; that is, that it shall be so stated that the general probabilities for and against its truth shall be as nearly as possible equal.

Adjusting Burden of Proof. But of course it rarely if ever happens that the two sets of probabilities exactly balance. Given almost any proposition, there is usually a presumption either that it is true or that it is not true, no matter how carefully it has been stated. But if such a presumption exists, there is no need of argument upon the side which it favors until something has been advanced upon the other side upon which rests the burden of proof, or as it may be called, the necessity of proof. A brief-maker has, therefore, not secured an ideal statement of his proposition until he has so

adjusted it that the balance of probability, if there is an appreciable one, that is the presumption, is opposed to him or against it; or so that he assumes the burden of proof. In debate, where both sides of a proposition are formally defended, this principle is of importance; and since the affirmative begins the discussion, the proposition must be so phrased that the burden of proof may rest upon the affirmative, which will require only the adding or omitting of a negative particle. When the burden of proof can not be otherwise determined, it is often assumed to rest upon that side of the proposition which opposes the conventional or established order of things. However, in general forensic briefs, dealing with matters which have already been largely discussed, the brief-maker may often assume that the place of the burden of proof cannot be ascertained, and ignore it entirely; since if he determined it by convention, he might be compelled to take the wrong side of his own argument. But he should always observe the principle when possible, remembering that unless he assumes the burden of proof, there is theoretically no reason why he should argue at all; the presumption being in his favor already.*

In phrasing a proposition so that the burden of proof may rest upon the one who is to defend it, the terms "an affirmative argument" and "an affirmative proposition," are sometimes confounded. The statement, "Private parties should not control natural monopolies," is a negative proposition because it contains a negative particle; but the argument which supports this proposition is at the same time an affirmative argument. That is, the argument which supports any proposition, affirmative or negative, is an affirmative argument; while the argument that opposes the same proposition is a negative argument.

Function of the introduction: expository. If the proposition has been as thoroughly prepared for discussion as is possible, reduced to the simplest and clearest and most concise and fairest statement that can be made, it may in this finished form receive the name that has been waiting for it, and be called a thesis. Perhaps, after determining the form of the thesis, nothing further may remain to be done except to formulate reasons for it, which is the actual making of the brief. But in practice it usually happens that after the indicated processes have been completed, it is still necessary to make more unmistakable the meaning of the terms, or to limit still further the application of the

Definition.

*This principle, however, holds only with regard to thesis and what are herein defined as main propositions; in introducing subordinate proofs the brief-maker may phrase each, if he can, so that the presumption shall lie upon his own side.

proposition. Even the simplest terms and relations may be understood differently by different people, and to avoid ambiguity and misconception it may be necessary to define and explain just what the user of them intends them to mean. The thesis may involve implied qualifications or limitations which he finds it necessary to state explicitly in order that he may show that he intends to accept or reject them. Full explanation may make it necessary for him to give a brief history of the origin of the question upon which the thesis is based, and of preceding discussions of it, in order to show why he takes his position, and where the burden of proof is to be placed, or to show that the thesis adequately represents the point at issue in the general question. Nothing is more common in popular arguments, especially those of the campaign type, than failure, intentional or otherwise, to clear up the subject by proper definition of terms, or proper attention to its origin; and the result may be a thesis easy to prove, but having little relation to the real subject of interest. Such a thesis as "The present deplorable state of Ireland is owing to internal conditions," can undoubtedly be defended in its present form; but immediately the question is suggested: Suppose it is, what then? and examination of the history of the Irish question would probably lead to the discovery that the real point at issue is better expressed by this proposition: England is not responsible for the present deplorable state of Ireland.

History of question.

Personal statement.

Somewhere in the introduction, usually at the beginning of it, or as a part of the history of the question, there is often given a statement of the writer's relation to the question, or of his reason for being interested in it, or for discussing it. Sometimes this statement is merely conciliatory, and would hardly be entitled to a place in the preliminary outline; sometimes it materially aids the process of defining and explaining. In general it may be said that the consideration of the personal relation of the speaker to the thesis may have a formal place in the introduction, but that his relation to the public addressed is a matter so dependent upon circumstances that the formal expression of it may be left until later, till amplification is under way.

Limiting discussion.

The principal business of the introduction is therefore to define the terms of the thesis, if they require definition, and to explain it fully, using whatever means is necessary. Finally, assuming that the thesis is definitely understood, it becomes necessary to fix limits for the discussion to follow. The thesis formulated, from the materials at hand reasons

for its truth begin at once to suggest themselves, and a preliminary analytical examination of them is next in order; for it is not necessary that a brief should contain all possible arguments, but only such a number as may be reasonably judged sufficient, and those chosen as the most cogent at hand. Moreover, in the brief of an ordinary debate or popular discussion, the length of the argument is usually limited by space or time to that adequate for the full presentation of not more than three to six principal proofs, each with its own support.

Evident and admitted arguments.

Every reason for the truth of a thesis is likely to present itself at first, as did the thesis, in a broad general form, its central meaning perhaps obscured by a mass of words. First of all it should be tested by introducing *for* or *because* as a connective between it and the thesis. If it is thus shown to be a reason, it should then be stated as concisely and accurately as was the thesis itself, and examined as to its fitness to have a place in the argument. It may prove to be too unimportant, when simplified, to have any place at all. If this is not the case, it may still be a self-evident proposition, or one having so strong a presumption in its favor or so generally admitted, that no proof or discussion or it is necessary, a bare statement of it sufficing. Should either of these conditions exist, the proposition belongs in the introduction rather than in the brief proper; and with it all others which satisfy the same conditions; that is, all which are admitted to be true by all parties to the discussion, and which at the same time have a material bearing upon the thesis.

Special issue.

It not infrequently happens that, after all the material has received a preliminary examination, the unimportant been thrown out, and the admitted facts stated, that but one principal reason for the truth of the thesis remains to be proved, and that upon the proving of it alone depends the establishing of the thesis. When this happens, this single reason, properly phrased and limited, is termed a special issue. If the preliminary analysis of the question and of the material bearing upon it has not been sufficiently thorough, it may sometimes happen that the socalled special issue is really a more accurate statement of the real point in the original question than is the assumed thesis; and that, as a consequence, the original thesis is to be discarded in favor of the new proposition, all definitions and preliminary statements based upon the former thesis are to be thrown aside, and the work is to be begun over again from the new starting-point. In other instances it is an essential part of the preliminary analysis to show that a

certain fact or proposition is really a special issue, and the exposition which shows it is of course itself indispensable. This often occurs in judicial process; as for example, if the principal thesis is that a certain person has committed a crime, as murder in the first degree, and it is admitted that he has taken human life, and that the act was not required in self-defense, or accidental, it may be shown that the special issue upon which the truth of the thesis depends is the single proposition that this taking of life was an act of deliberate intent.

Relation to thesis. If the preliminary analysis discovers such a special issue, it should conclude by showing that it *is* a special issue; that is that it bears to the thesis the necessary logical relation, and that it is sufficient to prove the thesis, after admitted proofs are taken account of. In a sense the special issue may be said to be equivalent to the thesis; that is equivalent to so much of it as is not already admitted to be true. If this practical equivalence did not exist, the special issue would not be a special issue, because additional argument would be needed to support the thesis. For example, if it were not admitted that A. B. had taken human life, premeditation would no longer be a special issue, simply because there would then be two issues. And if, therefore, a brief-maker can find but one reason to support a thesis, after enumerating those that are admitted, it does not necessarily follow that that one is a special issue; it may mean simply that he has not enough material at hand to base his discussion upon.

Summary as to introduction. From the preceding statements it will be seen that the introduction is purely expository; and that its general office is to define the thesis and to enumerate admitted proofs of the thesis. Its outline is then not a part of the brief, but precedes; and it is independent of the brief as to its logical structure. In detail, its functions may be indicated as follows, though some or all of them may be wanting in any given introduction:

- Introduction.
    - Definition.
        - Of terms of thesis.
        - Of meaning of thesis as a whole. (Both including history, illustration, or any form of general explanation.)
        - Possibly of author's relation to thesis.
    - Facts admitted in support of thesis.
    - Statement of special issue (if present).
        - Definition of meaning, as before.
        - Relation to principal thesis.

It is not so gratuitous as it may seem to state that in the actual

outline the word *definition* is not to be used, but the definition itself is to be briefly indicated, and so of the other terms given in the preceding outline; that is, the actual outline is to convey the substance of the introduction instead of merely indicating the nature of that substance. But it is evident that if we have found that there is a special issue and have completed the work which led to the discovering and determining of it, we are in a sense required to begin over again; for the special issue is simply a new thesis to be phrased, limited, and very possibly balanced and adjusted as carefully as was the principal thesis. Then it must in its turn be defined and explained, and finally, after it is shown to constitute the sole necessary proof of the principal thesis, we again begin to search out material, reasons, in support of it, as was done at first with regard to the principal thesis. And it is conceivable, even if not probable, that we might find a new special issue supporting the first one.

Although not generally advisable, it is possible to incorporate a part or all of the material belonging to the introduction in the brief proper, and this often happens, either through inadvertence, or through lack of clear analysis; while sometimes a part of the argument finds its way into the introduction, where it has no business to be. However, when as sometimes happens, definition and enumeration of admitted proofs are sufficient to show the truth of a thesis, or constitute an important part of the proof, the outline of either process or both may be made a part of the brief proper as indicated in the following outlines. The first assumes that there is a special issue; the second that several proofs are necessary to establish the thesis.

OUTLINE I.

P. The principal thesis is true, because—
- I. It means thus and so (definition).
- II. The following facts in proof are admitted (enumeration of facts).
- III. This proposition (special issue, stated) is true. (Proofs of special issue follow; argument proper.)

OUTLINE II.

P. The thesis is true, because—
- I. It means thus and so (definition).
- II. The following propositions are admitted concerning it:
  - A. (First admitted fact.)
  - B. (Second admitted fact, and so on.)
- III. The following propositions can be proved true concerning it: (Brief proper.)
  - A. First proposition.
    - a. Proof.
  - B. Second proposition.
    - a. Proof, and so on.

But these outlines are given, not for imitation, but to show how confusion of introduction and brief proper may occur because of what may be termed the argumentative bearing upon the thesis of material that is really expository. In practice, these two classes of material should be carefully distinguished, and as far as possible kept apart. So far as the introductory processes are concerned, this can always be done; but when as often occurs, incidental exposition must be used in the course of the argument, it may when necessary be incorporated into the brief proper as indicated.

Brief proper. As a rule, then, an expository outline of the form first given (p. 133) precedes the brief proper. Then, when the preliminary processes have been completed, and an outline of them made, at the head of the brief proper is placed either the principal thesis, or in place of it as a secondary thesis the special issue if one has been found; and the next thing in order is to search the material at hand for proofs, that is reasons showing that the thesis is true. A convenient method of getting this material in hand will be to jot down the reasons in any order that may suggest itself, in what may be called a trial outline of the argument, of this form:

Trial outline.

P. The thesis is true, because—
- I. (General reason stated.)
- II. (Another general reason stated.)
- III. (Another general reason stated, and so on.)—

the total number of such general reasons, as has been already said, not likely to exceed five or six, if there are so many; although there is, of course, no actual limiting rule, except that the first classification of the material should aim to resolve it into as few and as important divisions as practicable.

Analysis. This trial outline must next be submitted to the severest analysis, not because of the possible danger that some one may happen to find a flaw in it after it has been made public, but to ensure its correctness on general principles. General popular practice is even more careless at this point than it is in formulating the thesis.

Excluding, phrasing, limiting. The statements in the trial outline may first be examined to determine whether any of them are comparatively unimportant, and therefore such as may be omitted with advantage, since it is not the number but the cogency of the arguments that counts. If any of them are found to be practically self-evident or generally admitted, their place is, of course, in the introduction, unless they are excluded altogether; for at this

stage the brief deals only with statements that will themselves require to be proved later. Next in order is the simplifying and limiting of each of the statements, precisely as was done with the principal thesis. As at first jotted down, some of these are likely to be long and complex, perhaps containing more than one sentence. Each is to be reduced to a single proposition that embodies the central meaning; and if, as is very likely to happen, it is found that the first form of a statement contains not only a central proposition relating to the thesis, but reasons which show the truth of the central proposition itself, these reasons are to be kept in reserve, and given a place as subordinate proofs after the proposition to which they relate. Further, it often happens that when a given series of statements are resolved each into its principal and subordinate parts, it is found that one statement contains material that logically belongs to another. In this process, a statement that involves a compound sentence should be examined to see whether it is not equivalent to two independent and equal proofs; and a complex statement containing a principal member and others bearing to that one the relation of cause, concession, inference, or result, should be analyzed to determine which part of it is proof of the principal thesis, and which parts are merely proofs of the other part.

At this stage of the process, if some of the statements have been found to contain subordinate proofs, the trial outline begins to look like this:

P. The thesis is true, because—
- I. Proposition I is true.
- II. Proposition II is true; because—
  - A. Sub-proposition A is true.
- III. Proposition III is true, because—
  - A. Sub-proposition A is true.
  - B. Sub-proposition B is true, and so on.)

Every part of the trial outline is now supposed to be a definite, concise proposition each conveying a single assertion, and containing only such modifying elements as are necessary to make the assertion exact; the fewer the better.

Order of propositions. Having eliminated the unimportant statements, relegated those that need no proof to their place in the introduction, simplified the rest and resolved them into their logical elements, the brief-maker may next consider whether the resulting propositions are arranged in the most effective order. They were at first noted down as they happened to suggest themselves; but are now to be arranged with especial reference to the

principle of emphasis; so that a strong argument may be used to open with, the strongest of all to close with, while those less effective are distributed through the middle. Sometimes circumstances, as the character of an audience to be addressed, may aid to determine what are the most effective arguments in hand; at other times it may be necessary to determine purely by their logical bearing upon the thesis As a rule, deductive arguments are more effective than inductive ones, and may receive the places of honor; but the rule has so many exceptions in practice, that it is often better to consider the subject matter of a proposition rather than its logical nature, only taking care that it shall in every instance be able to endure a logical test if such a test is applied.

Relations to thesis. To ensure the logical effectiveness of the arguments is of course the most important thing to be considered in making a brief; and it depends upon the nature of the relation to the principal thesis of the proposition as now simplified. The correctness of this relation was broadly indicated in the beginning by supplying the connectives *for* or *because* between thesis and proposition. But this by no means indicates how far a proposition goes toward proving the thesis, nor does it actually establish a logical connection between thesis and proposition; since others than children sometimes introduce statements with *because* that are not reasons after all. And if the proposition advanced is really a reason, or a proof as it may now be called, it is still necessary to determine its weight, how to present it, and if necessary how to defend it.

Classification of relations. A broad classification of the possible relations which proof may bear to thesis resolves them into inductive, deductive, and what may be termed refutative, used in clearing out of the way opposed arguments. The inductive relations have been classified in various ways; though a classification that is simple and at the same time complete and satisfactory is not easy to find, because of the infinite variety of detail which inductive arguments present as they occur in actual practice.

Inductive relations. The characteristic of all inductive arguments which distinguishes them as such is that they are less general than the thesis, that is less in content or inclusion, so that they are merely indications of its truth. They establish according to their number and weight a less or greater degree of probability that the thesis is true, sometimes reaching a "reasonable certainty," but rarely if ever that absolute certainty which is called demonstration. The following tentative classification and definition will per-

haps serve to make clear the nature of the principal inductive relations, here stated in a conventional order:

INDUCTIVE RELATIONS.

P. The thesis is probably true because its truth is indicated as follows:

I. There exists or has existed an antecedent probability that it is true. That is, causes exist from which the thing asserted in the thesis would probably follow as an effect; as for example, a motive for the committing of the crime, in a trial for murder. This is also called *a priori* argument.

II. There is a sign that the thesis is true, of this nature: Something is true that might have resulted from the existence of the thing asserted in the thesis as a cause. For example, certain irregularities in the motion of the planet Uranus indicated that there might be an unknown planet beyond it. This is also called *a posteriori* argument.

III. There is a sign that the thesis is true, of this nature: Something is true that usually accompanies the thing asserted in the thesis. The two may be common effects of the same cause. For example, a red sunset is said to indicate that the following day will be clear. This is also called argument from attendant circumstance.

IV. There are examples indicating that the thesis is true; that is, cases of the same character as that to which the thesis relates, involving similar attendant circumstances, in which the thing asserted in the thesis is or was true. The case which is compared with that to which the thesis relates may be another member of the same group; or the thesis may relate to the entire group, and the example may be that of a member of the group. For example, cited cases of poisoning by arsenic may indicate either that arsenic will be fatal to a particular man who has taken it (another member of the group man), or that it will be fatal to any and every man who may take it (the entire group), provided of course that the attendant circumstances are substantially the same throughout.*

V. There are analogies indicating that the thesis is true; that is, cases bearing in some specific respect a resemblance to that to which the thesis relates, involving similar attendant circumstances, in which a thing resembling that asserted in the thesis is or was true. The cited case generally belongs to an entirely different group from that to which the thesis relates. For example, cited cases of poisoning of human beings might indicate that the same poison might prove fatal to a horse, or to a fish, or to a plant, if introduced into the circulation in each instance; the degree of probability lessening as the resemblance between the cases decreases.

Relative weight. Of these five forms, the relative weight from stronger to weaker is approximately that in which they are given. That of the first four is however largely dependent upon the circumstances attending their use. Professor G. P. Baker (Principles of Argumentation, p. 206, ff.) measuring them by the degree of resemblance between the case to which the thesis relates and the case cited in proof, ranks them in the order,—analogy, antecedent probability, sign, example; or, expressed by the preceding numerals, the order V, I, III, II, IV. Analogy and example, V

*Example involving dissimilar attendant circumstances is sometimes classified as analogy. See citations in A. S. Hill, Principles of Rhetoric, p 364, ff.

and IV, may easily be compared in this way, and their effectiveness ranges from a possible zero in argument from analogy to a high degree of probability in argument from example. Another comparison may be made through the relation of causality instead of that of resemblance. In analogy the existence of a causal relation is suggested by the resemblance noted, and in example such a relation is assumed (Hibben, Inductive Logic, p. 44). Arguments I, II, and III often depend more explicitly upon a known or assumed causal relation. They are based ultimately upon analogous or like cases, but in them reference is made to the principle of causation rather than to the individual cases which indicate the existence of the principle. If the causal principle is merely assumed to exist, these are not more but rather less weighty than IV, as indicated in Professor Baker's classification. If, however, the existence of the causal principle is known or admitted, these may assume greater importance than IV, in that each of them implicitly stands not for one but several examples; while again, if the causal principle be known to be in operation in IV, it may be restored to its leading position. As to the relative weight of I, II, and III, if the cause cited in I were the only cause necessary to produce the effect which the thesis asserts, it would at least equal II and III; but as usually many causes, several of them likely to be unknown, are concerned in a given effect, I is as a rule less weighty than the other two.

Direct evidence. But the preceding classification, while it serves to indicate the general nature of any inductive argument that occurs in ordinary discussion, is still incomplete. The classes enumerated, whether the material in each be obtained by the brief-maker from some one else or from his own experience, all belong to what is called indirect evidence (not to be confused with indirect reasoning, which is a name often given to refutation). Each class presents facts from which the truth of the thing asserted in the thesis may be inferred. Direct evidence, from which these forms are distinguished, is merely the statement of some one, the brief-maker or another, that the fact asserted in the thesis is true because he has seen it to be true. It differs from indirect evidence, not in being without the element of inference, but in containing a smaller proportion of it; since the one who asserts a thing to be true because he has seen it has still drawn an inference from facts presented by his senses, though the connection is so immediate that facts and inferences can not easily be separated. If the relative weight of the various form of indirect evidence is measured by de-

grees of resemblance between the case to which the thesis refers and the case cited in proof, then direct evidence can be compared with indirect by noting that in direct evidence the resemblance is more nearly complete. The statement is perhaps less helpful inasmuch as when direct evidence is reached, the thought of resemblance between two cases is likely to disappear, the case to which the thesis refers receiving sole attention.

Direct evidence usually establishes a higher degree of certitude than any of the preceding forms. An illustration of it was the actual observation of the planet Neptune with a telescope, after its existence had been shown to be probable by *a posteriori* reasoning. This from the standpoint of the observers was "judgment after full experience."* Apparently, if the stage of complete or nearly complete experience can be reached, the argument is conclusive, rendering unnecessary all that has preceded, and amounting to demonstration. But while the "full experience" of the brief-maker might, from his point of view, be equivalent to demonstration, it is necessary for him to remember that his own full experience is not at all the full experience of those whom he intends to address; but that to them he is merely a witness. Even from his own point of view, the direct evidence of his senses is still to be tested, and any doubt of their accuracy destroys the certitude, and relegates the argument to its place in the inductive system, though it may still be the strongest of all. The attempt to reach this higher degree of certitude is characteristic of scientific as distinguished from popular induction; but the scientist, even when he reaches this stage, is not content with a single observation, nor, perhaps, with the observations of a single observer, but repeats them, each observation, of course, adding a proof, until the number is sufficient to establish a reasonable certitude, or to make a demonstration.

Availability of direct evidence. To the brief-maker, the direct evidence of some one else is less conclusive than his own, since any man is likely to believe in his own experience rather than in that of another. To the public addressed the difference is not so great, since the brief-maker is himself but a witness, so far as the public is concerned; but he has the advantage of other witnesses in that he presents his evidence in person, while other evidence is necessarily presented through him, is thereby once removed from its source, and is more nearly like hearsay. If either

*Fletcher and Carpenter, Introduction to Theme Writing, p. 130, **Baker, Argumentation**, p. 212. See also following section of this article, on testimony and authority.

sort of direct evidence happens to be available, it must not be overestimated, but must be carefully tested externally and internally, and its weight determined as accurately as may be. If it is the direct évidence of the brief-maker himself, he is more likely to overestimate it, and must be on his guard against the error; testing himself as he would test anyone else. But in general it is true that in ordinary brief-making, direct evidence is not available at all until subordinate proofs are reached. In debate, or in general discussion, theses are usually of such a nature that their truth can not be observed directly by any one; either because direct observation is physically impracticable, or because they relate, not to matters of fact, but to matters of opinion, expediency, probability, the future; to the abstract rather than the concrete. There is no opportunity for direct argument to show that capital punishment should be abolished, or that the United States government should own and control all railways in the United States, that is so far as the principal theses themselves are concerned; but on the other hand, there may be opportunity for the introduction of direct evidence in some subordinate part of the proof. It may be argued that the United States government should control railway transportation because the German government does so successfully; and the latter proposition may be declared true because the brief-maker has himself visited Germany and made personal investigation into the workings of the German system. This would be direct evidence of the most direct type; yet it is apparent that there would still probably be mingled with it a great deal of inference from indirect evidence, and probably much direct evidence of others than the brief-maker, restated by him and therefore secondhand.

Testimony and authority. For practical purposes the distinction in weight between evidence derived from the brief-maker's own experience and that which he obtains from the experience of some one else is not great; but it is nevertheless a difference, even to the public addressed. It is the difference between a witness giving his testimony in person, and a witness quoted by another. Then, if we regard all the arguments hitherto classified as derived from the experience of the brief-maker, there remains from his point of view a distinct class comprising the arguments from authority and testimony, not yet named. Moreover the distinction may be made the basis of a new classification of inductive arguments according to degrees of experience of the brief-maker, to which correspond degrees of certitude in his own mind, producing corresponding if inferior degrees of certitude in the mind

of his public. This classification resolves his judgments into three principal groups; judgments before experience, judgments after partial experience, and judgments after full or complete experience.* Roughly tabulated, these groups comprise:

- I. Argument before experience on the part of the brief-maker, but based on the experience of others (testimony and authority).
  - A. Incomplete or partial experience of others (their indirect evidence, forms already classified).
  - B. Full experience of others (their direct evidence).
- II. Argument based on incomplete or partial experience of the brief-maker himself (indirect).
- III. Argument based on the full experience of the brief-maker (direct).†

According to this classification, testimony and authority, sometimes called arguments from sign, really include every form of induction, but with the source in each instance one degree farther removed from the brief-maker and from the public addressed, and correspondingly less weighty. The general distinction between testimony and authority may be thus stated. Testimony presents facts from which others than the witness are to draw an inference (indirect evidence), until the inference from the facts becomes so immediate that it cannot be separated from the facts and both are presented together as direct evidence, based on the "full experience" of the witness or on "complete resemblance" seen by him. Authority is allowed to present facts and inferences also, whether the evidence is direct or not; and may even sometimes present the inferences from indirect evidence without the facts upon which they rest; that is to say, the mere opinion of authority is sometimes accepted as argument. If the evidence of authority is presented by the witness in person, it becomes expert evidence; if in his absence, through documents, it may be called authority proper. The relative weight of testimony and authority depends chiefly upon the degree of directness of each; that is, in the preceding terminology, upon the degree of their relative nearness to complete experience, or the degree of relative completeness of resemblance; and also of course upon the character and standing of the witnesses, the tests of which will be enumerated later.

The following outline is an attempt to classify from the point of view of the brief-maker all the inductive processes. It embodies

*This classification differs from that given by Professor Baker in that in holding to the single point of view stated, it designates the direct evidence of a witness as a judgment before experience (of the brief-maker), and excludes from the judgments before experience all resemblances seen by the brief-maker. The presence of the latter in the category assigned them by Professor Baker, seems, even according to his own method of analysis, to be a logical impossibility.

†Regarded from the point of view of the public addressed, all these become judgments before experience; and II and III then become testimony, or authority.

the preceding distinctions, is subject to qualifications and contingencies such as have been stated, and leads in a general way from weaker to stronger. The cross divisions make some repetition necessary.

FINAL CLASSIFICATION OF INDUCTIVE ARGUMENTS.

I. Proof based on the statement of others than the brief-maker. (All forms of evidence.)
  A. Authority; stating facts, or opinions or inferences based upon the facts, by a witness competent to draw inferences.
    1. Witness present in person (living), expert evidence.
      a. Indirect; facts related to thing asserted in thesis, and opinion or inference as to thing asserted in thesis.
        1'. Opinion or inference alone.
        2'. Facts, and opinion based upon them; facts bearing to opinion all the indirect relations: analogy, antecedent probability, example, attendant circumstance, a posteriori.
      b. Direct; the thing asserted in thesis, fact and opinion inseparable, (full experience, complete resemblance).
    2. Witness absent (dead); documents, authority proper.
      a. Indirect (same subdivision as under 1, a).
      b. Direct.
  B. Testimony; stating facts but not inferences, except such direct ones as are inseparable from the facts; any witness, brief-maker drawing the inferences.
    1. Indirect; facts related to thing asserted in thesis.
      a. Analogy. b. Antecedent probability.
      c. Example. d. Circumstance. e. A posteriori.
    2. Direct; thing asserted in thesis (full experience, etc.).

II. Proof based on personal investigation of the brief-maker (still evidence from point of view of the public addressed).
  A. Indirect.
    1. Analogy. 2. Antecedent probability. 3. Example.
    4. Attendant circumstance. 5. A posteriori.
  B. Direct; full experience of brief-maker, complete resemblance perceived by him, as to thing asserted in thesis.*

Some difficulties in classification. No matter how carefully inductive proofs may be classified, they differ so greatly in minor detail that it is often easy to mistake one for another, and difficulties frequently arise in deciding as to the proper classification of a given proposition. These difficulties are usually of minor import-

*The scientist's inductive process aims to reach the highest degree of certitude by adding experiment to observation when practicable. If the preceding outline were extended to take account of this additional distinction it would be doubled in length; since all the material outlined in it can be assumed to be based upon observation, and as much more might theoretically be obtained by experiment. In ordinary reasoning the distinction is rarely if ever necessary, and the brief-maker does not need to take account of it; while if it occurs at all, it is likely to be as a subdivision of his own direct proof (II, B. 1. Observation, 2. Experiment).

ance; or of none at all.* Two of them are here illustrated. The first is of this type:

P. A certain course of action should be adopted, because—
   I. It will lead to certain desirable results.

The question is, is the relation between I and P antecedent probability, or sign *a posteriori?* It is arguing from the desirability of certain results or effects to the desirability of having a cause which will produce them; and since effects are as a general thing, later than causes from this point of view the relation seems to be *a posteriori.* But the specified results do not exist; and the real point is merely that they are desirable. Because they are desirable, a motive is therefore shown to exist for taking the step necessary to secure them; in other words a cause exists for taking the specified course of action; and this is the argument from antecedent probability.

The second illustration is of a kind equally familiar, and may be assumed to follow the preceding one as a part of the same reasoning:

I. A certain course of action at X college (e. g. making gymnasium training compulsory) will lead to desirable results.
   A. It will develop better health in the student body.
   B. It will increase mental activity; etc.

Students usually regard A and B as examples; but, strictly speaking, argument from example would be of this form:

A1. It has led to desirable results at Y college;—

or perhaps this:

A2. It has led to desirable results in the case of John Smith.

These come far short of establishing I; while A and B (assuming that they are proved) are practically equivalent to I; for "desirable results" means some desirable results, more than one; and A and B together are equivalent to "some." This then, if A and B are true, is more than an indication of the truth of I, it is practically a demonstration of it; and it is thus suggested that the relation under examination is very nearly a deductive one. In fact, if A and B

*It is possible that one of these minor errors occurs on page 203 of Baker's "Argumentation." It is there stated that, when analogy suggests a motive for an act that is to be proved, if the analogy is a real one the analogy immediately becomes antecedent probability. According to the illustration there given, the meaning seems rather to be that the analogy establishes an antecedent probability, as any inductive argument may be used to establish another; and the analysis of the argument mentioned therefore takes this form:

P. There was unfair tackling in a certain foot-ball game.
   I. Because there was a motive for unfair tackling (antecedent probability).
      A. Because the situation of the accused team was as critical as that of a drowning man who catches at any straw to save himself (analogy).

But so far as the weight of the argument is concerned, one statement is as good as the other.

are united in a single proposition, we may then construct this syllogism to unite them with I:

What develops health and mental power therein leads to desirable results.
Compulsory gymnasium training develops them.
Compulsory gymnasium training leads to desirable results.

But it is often more convenient to separate A and B in view of the fact that each may require a separate sub-proof, probably by example; and when separated each proves a part only of I and each separately considered is an indication that the whole of I is true. This is reasoning from a part to the whole; practically the same thing as reasoning from an individual to a class, except that in the latter, completeness of enumeration is rarely if ever possible, while in arguing from a part to the whole it may be possible to reach complete enumeration, in which case we pass from probability to certainty. But the reasoning is so closely related to argument from example that it may conveniently be included with it; and it suggests a corresponding extension of the definition of analogy to include reasoning from a part of one whole to a part of another whole resembling the first; the two wholes not belonging to the same class, or else the two parts not corresponding.

Deductive relations. While inductive relations are often complicated and puzzling, the classification of deductive relations presents very little difficulty. Deduction differs from induction in that, while induction gathers indications of the truth of a thesis which lead only to probability, rarely to certainty, since the conclusions almost invariably include more than is to be found in the propositions upon which they are based, deduction actually proves that the thesis is true by bringing in support of it propositions that include it, or are, taken collectively, its logical equivalent. A tabulation of deductive relations, excluding such as are not in ordinary use, is as follows:

DEDUCTIVE RELATIONS.

P. The thesis is true, because—
  I. A proposition which includes it, and implies another stating the inclusion, is true
  II. A proposition which is equivalent to the thesis because it implies another proposition in which the thesis is included, is true.
  III. Two propositions, one including it, and the other stating that inclusion, are true.
  IV. There are no alternatives which can be true.

To this may be added, as occasionally used, and having the force of deduction--

  V. A proposition precisely equivalent to it (perhaps a definition or an inversion of it) is true.

Finally may be added the argument from part to whole when complete enumeration is reached:

VI. Several propositions which taken together equal it are true.

The first of these six forms is the most familiar, and the most familiar illustration is this:

P. John Smith must die (at some time).
I. All men must die (are mortal).

In this illustration, the fact that I includes P is so evident that the need of supplying the implied proposition does not seem to exist. But another illustration, taken from a student's paper, will show that there is such a need:

P. Football should be prohibited at X University.
I. All brutal games should be prohibited at the University.

That something is wanting here is obvious; and when the implied proposition, I_0, Football is a brutal game, is supplied, it is also obvious that the three propositions, I, I_0, P, constitute what is technically known as a categorical syllogism; I its major premise, and I_0 (zero subscript denoting implication) its minor.

II preceding is perhaps sufficiently explained by saying that it is the minor premise of such a syllogism, the major being implied; as for example:

P. This man should be subjected to capital punishment.
I. He has committed the crime of wilful murder.

The implied proposition or major premise, II_0, is: Whoever commits the crime of wilful murder should be subjected to capital punishment.

In III preceding, the two propositions of the syllogism are both expressed, and it appears therefore that I, II, and III, are all the same form of argument differently expressed. An example of III is:

P. The product of an author's thought should receive international protection.
I. All property should receive international protection.
II. The product of an author's thought is property.

An argument of class IV may be stated in any of several ways. The following is the more ordinary method:

P. Boston should increase its facilities for rapid transit by constructing deep subways, because—
I. An extension of the present surface facilities is impracticable.
II. A system of elevated roads would not answer the purpose.
III. Subways near the surface would be objectionable.

This statement leaves two propositions implied. Supplying one of these, the statement becomes:

P. Boston should (etc, as before).
  I. None of the suggested alternatives (enumerated) will answer the purpose as well.
    A. Extension of surface roads impracticable.
    B. Elevated roads will not do.
    C. Subways near the surface objectionable.

When both implied propositions are stated, the form becomes:

P. Boston should (etc. as before).
  I. Boston must increase its present rapid transit facilities (in some way, implication of all possible methods).
  II. Of suggested methods, all but one are objectionable.
    A, B, and C as before.

In this complete form, I, II, and P, constitute what is known as an alternative syllogism. In stating the argument, the minor, (II) is often left unexpressed because it may be directly inferred from the supporting propositions (A, B, and C). The major premise (I) is stated when it requires to be proved; otherwise, like the major of a categorical syllogism, it is left unstated, or is given in the introduction. The entire process thus indicated is usually called argument by exclusion of alternatives.

Class VI is illustrated by the preceding proof of II by A, B, and C.

An illustration of class V is:

P. Boston needs to increase its present rapid transit facilities.
  I. Because its present facilities are inadequate.

This argument examined by syllogizing becomes:

I_0. Not to have enough of anything is to need an increase of it.
I. Boston has not enough facilities for rapid transit.
P. Boston needs more such facilities.

This process, otherwise gratuitous, shows that class V, if it constitutes argument at all, is practically the same as class II. Then classes I, II, III, and V, are all merely different forms of the same categorical method; IV and VI both belong to the alternative method; and the six classes are therefore reducible to two principal groups.*

Indirect or refutative relations. There remain to be tabulated the classes of refutative relations, exemplified in propositions that support a thesis by answering objections to it.

REFUTATIVE RELATIONS.

P. The thesis is probably true, because—
  I. The thesis which opposes it is not true.

*Hypothetical argument and dilemma are ignored because the former is reducible to categorical form, and the latter is rarely used.

II. The argument which is used to support the opposing thesis is not true.

III. There is a fallacy of process in the argument which is used to support the opposing thesis.

These are scarcely indications of the truth of the thesis, since showing the falsity or error in an opposed argument simply removes that argument from consideration, and leaves the principa thesis still unsupported, except by the probability that it may be true since an opposed argument has been overthrown. Generally stated, the principle is that a thesis can not be proved beyond a certain slight degree of probability by disproving an opposed thesis; though it is at the same time true that to prove a thesis does absolutely disprove the opposed thesis. But if two opposing theses are logical contradictories—are alike except that one contains a negative particle which the other does not—or if the two comprise within themselves the only possible alternatives, it is then true that to disprove either proves the other. The following illustrations of the preceding classes will make this clearer.

An illustration of I is:

P. The government should own and control the railways of the United States. because—
 I. Private parties should not own and control them.

This assumes the existence of a negative thesis opposed to P, of this form—

—P. Private parties should own and control the railways.

and proceeds to contradict it. The contradictory I of —P being duly established, —P is thereby overthrown; but the support of P has not been increased by the process of removing an opposing weight; the defense of it has simply been made easier. If, however, it is understood or shown that P and —P are the only possible alternatives, then I with its support, disproving —P, becomes actual direct deductive proof of P, through an alternative syllogism.

An illustration of II is the following:

P. Government should own and control the railways, because—
 II. It is not true that government control would lead to an increase in political corruption.

This assumes the existence of the logical contradictory of P as a negative thesis, supported by the contradictory of II:

—P. Government should not own and control the railways, because:
 —I. Such control would lead to increased political corruption.

If II is adequately supported —I is thereby disproved; but the re-

moval of —I does not overthrow —P, but leaves it unsupported; so that as before, the defense of P has merely been made easier.*

Class III may take this form:

P. Government should own and control the railways, because—
    III. Those who say that political control will lead to political corruption are in error as to the source of such corruption.

This has in view the last negative argument stated, —P supported by —I, and aims to show that —I does not apply because it involves the mistaken assumption that government control is a necessary cause of political corruption. While, theoretically, this does not disprove —I but simply deprives it of weight, yet, if III is properly supported, as perhaps by such a proposition as this—

A. The efficient cause of political corruption is the arbitrary exercise of the appointive power (not a necessary consequence of government control),—

it in effect destroys —I by establishing its contradictory, and there remains no essential distinction between II and III. But when III simply brings the charge of error against —I, or states that no necessary connection has been shown between government control of railways and political corruption, or that government control if it is a cause is perhaps not a sufficient cause, the result is not to overthrow —I, but to render it ineffective by showing that it needs further support.

From the illustrations, then, it appears as was stated at first, that refutative arguments have as a rule, so far as the principal thesis is concerned, only the effect of removing obstructions from the way of the direct argument. Whatever further support refutation may give to direct argument is usually moral rather than logical.

General conclusions as to order of propositions. Having completed this rough if somewhat lengthy classification and analysis of the relations which proofs may bear to thesis, we may determine with some accuracy the logical nature of any propositions which are shown by the test connectives *for* and *because* to be really proofs, and to draw some conclusions as to their relative weight or importance. Inductive arguments are classified on page 143, in what is approximately their order of importance; and deductive arguments, if correct and properly supported, are theoretically stronger than inductive ones. A general conclusion is that after opening with an effective argument, refutation and indirect evidence should precede

*An interesting logical situation might result from introducing as sub-argument under II the logical opposite of —I. which would in the brief be marked A:
    A. Government control will decrease political corruption. (presumably by extending the sphere of civil service).
This if established would overthrow —I and leave —P unsupported as before; but at the same time it could be used in another place, as a direct argument *a priori* in support of P, and thus made to do double service.

direct evidence and deduction. But the procedure in any particular case is governed by circumstances. In debate it is a common practice to begin with refutation; and convenience, or some suggestive relation in the subject matter may decide the order of other parts of a brief. Induction and deduction may alternate; and it is to be remembered that a deductive argument may be so questionable as to be inferior in importance to an inductive one.

Number of propositions of given class. If of equal validity, a grenter number of inductive arguments than of deductive ones is necessary to establish a thesis to a requisite degree of probability, since an inductive proposition merely indicates truth, while a deductive one should establish it, or contribute an essential part toward complete proof. But in practice the difference is not very great, since in deduction the truth of the conclusion depends upon the truth of the premises, and the premises themselves are very likely to rest upon induction. An analysis of the material at hand will serve to determine what should be the number of the proofs more effectually than any theoretical rule.

Induction distinguished from deduction. It sometimes happens that notwithstanding the time devoted to practice in classifying arguments, a brief-maker is at a loss to determine whether a given proposition bears an inductive or a deductive relation to the principal thesis; the temptation being to assume that the relation is the more conclusive one. If we have, for example, this reasoning—

P. Capital punishment should not be abolished, because—
  I. It is a powerful deterrent from crime,—

it seems evident that while I may be regarded as an argument from antecedent probability, it may also be regarded as the minor of this syllogism:

I_0. No punishment that is a powerful deterrent from crime should be abolished.
I. Capital punishment is such a deterrent.
P. It should not be abolished.

If deduction is theoretically stronger than induction, why should not I be assumed to be deductive reasoning? The answer is that if it is not really deductive, to assume that it is may enable an opponent to destroy it with a touch. The truth of the conclusion to be drawn from deductive reasoning depends upon the truth of the premises as well as upon the correctness of the process. The minor of the preceding syllogism we may assume to be proved; but the implied major, unless self-evident or admitted to be true, must also be proved. A glance at it shows that it does not satisfy any of the conditions; but that it may immediately be proved untrue by

reductio ad absurdum, showing that it does not have the inclusion asserted:

No punishment that is a powerful deterrent from crime should be abolished.
Burning at the stake is a powerful deterrent from crime.
Burning at the stake should not be abolished.

Hence the only safe assumption is that the relation of I to P is an inductive one. If any doubtful case is not easily resolved by an analysis of this sort, it may in general be safer to interpret the reasoning as inductive, thereby assuming for it at most no more than its value. In doubtful cases, however, it will usually be found, either that the proposition is not correctly stated, or else that it is not a proof at all.

Proofs of propositions. When the propositions have been analyzed, properly stated, and arranged in effective order, the main outline of the brief proper is completed. At this stage the brief consists* of a limited number of propositions, each bearing to the thesis some one of the relations indicated, and all therefore cöordinate. But, if it be remembered that all self-evident or admitted proofs were relegated to the introduction, it necessarily follows that each of these propositions, which may be called main propositions, is an assertion; which is equivalent to saying that there is a presumption that it is not true, and that it must therefore be proved.

Sub-propositions. Each main proposition is therefore precisely in the position of the original thesis; and each is in its turn to be supported by still other and subordinate propositions bearing to it some of the classified relations. But now a difference appears and may be utilized; else the process would be interminable, each new proposition requiring to be proved, and so on forever. The main propositions could not be self-evident or accepted, but there is no such restriction upon the subordinate proofs; and if now the brief-maker can find self-evident propositions, or such as have a strong presumption in their favor or are generally accepted, he ought to use them in order to reach an end at that part of his argument; for if such sub-propositions are found, they require of course no further support, and the brief is complete at that point. But some of the sub-propositions will not belong to any of these classes, and will require to be proved in their turn; and this will require the use of what may be called sub-sub-propositions to support them, which must again be either evident, admitted, or proved by propositions still more subordinate; until the chains of reasoning which

*Theoretically; subordinate propositions have doubtless appeared and have been noted down, but are not yet formally taken into account in this discussion.

support each main proposition all end in propositions which require no further proof. When this is accomplished, the brief is theoretically complete.

In practice, however, it may happen that such a chain is inconveniently long. To avoid too great elaboration, the brief-maker may stop at a convenient point in the chain, indicating that it is not complete, and may reserve the presentation of the subordinate proof for the amplification; or he may, instead of separating each step in a chain of reasoning from all the others, mass them together in a single statement. But the latter practice is a dangerous one, as it tends to cover up errors, to develop a habit of making analysis superficial, and to make the presentation of the argument less clear. Until the brief-maker is sure of his methods, he should make it a rule to designate each step in a chain of reasoning by a single proposition as simple, concise, and exact as the thesis itself.

Details as to phrasing sub-propositions.

The preceding statement suggests a point or two of detail. In induction, especially in the various forms of example and analogy it is often possible to represent a proposition by a word or two. For example,

P. Present copyright laws do not adequately protect American authors.
  I. Example of "Uncle Tom's Cabin."
  II. Example of Bancroft's "United States."

But this is evidently not an exception to the principle stated; for I and II imply distinct propositions; I standing for—

I. Mrs. Stowe's "Uncle Tom's Cabin" is not adequately protected—

and II for corresponding statement.

The second point concerns the phrasing of propositions that are parts of a deductive argument. The logical rules of the categorical syllogism require that the three propositions constituting the syllogism shall contain but three terms, each term used twice in precisely the same form, except a possible difference in inclusion or distribution.* But in making a brief, it often happens that a proposition which really bears a deductive relation to another proposition is stated in terms so different from those in the other proposition that the two cannot be formally joined in a syllogism, although the necessary relation in meaning may exist; while to change a term in one proposition to the form of the equivalent term in the other proposition requires the one proposition to assume a form that is awkward, perhaps even ungrammatical. An illustration of this point is—

*A term is said to be distributed when it includes every member of the class named, or when the word *all* may be understood before it; it is undistributed when its inclusion is not complete, or when the word *some* may be supplied before it.

P. An international copyright law should be secured.
  I. The product of an author's thought should receive international protection.
    A. All property should receive international protection.

When these propositions are brought into syllogistic relation, they must be enunciated as follows:

P. An international copyright law should be secured.
  I. An international law to protect the product of an author's thought should be secured.
    A. International law to protect all property should be secured.

The phrasing of I and A in this second form is not very awkward; but the question is whether any attention should be paid to syllogistic requirements when they are expressed in the brief. For general convenience and accuracy, it is better to express them in accordance with those requirements, or approximately so, without, however, going so far as to do violence to the language. This becomes easy with practice, and practice will also make it easy to determine that the logical relation is correct, without resorting to formal syllogizing. Inductive arguments, of course, do not present this difficulty.

Testing of completed brief.

Before the brief is ready for service, there remains only to subject it to a final test, to insure that it shall not involve any error of process, any logical oversight or fallacy that might prove embarrassing if discovered by an opponent, or by any one else. Perhaps the principal tests may be most concisely given as a series of questions, arranged in the general order of the preceding classification of arguments.

Possible fallacies.

TESTS OF INDUCTION.

I. *Tests of evidence* (external tests; see Baker, Argumentation, p 242).
  A. Expert evidence.
    Is the witness competent through intellectual power, training, and experience, to observe correctly, and to base a reliable opinion upon facts observed?
    Is the witness unprejudiced by personal or professional bias?
  B. Authority proper.
    Is the record authenticated?
    Was it made by one who could meet the tests just named for expert evidence?
  C. General testimony.
    Is the witness competent, mentally, physically and morally?
    Is he willing and unprejudiced?
    Is the evidence consistent with ordinary experience, other evidence, and with itself?
    Is it probably true because undesigned, or prejudicial to the witness who offers it?

II. *Tests of inference* (internal tests).

A. Antecedent probability.

Is the assumed probable cause (or motive) really a cause at all. If not, this is the fallacy *non causa pro causa*.

Is the assumed cause in itself sufficient to be taken account of? May not its action depend upon so many other coincident causes as to destroy the probability that it produces any effect?

B. Sign, a posteriori.

Does the assumed causal relation between thesis and sign really exist? If not, this is the fallacy, *post hoc, ergo propter hoc*.

C. Attendant circumstance.

Is the attendant circumstance invariable (is there a causal relation involved), or is it merely accidental?

D. Example.

Is the example actually of the same character as the case in question, and are the attendant circumstances really the same or very nearly the same in the two cases?

E. Analogy,

Is there a real, not a fancied resemblance between the analogical case and the case in question, and are the attendant circumstances the same or very nearly the same in the two cases?

III. *Tests of observation* (direct).

Has the observer actually witnessed the fact in question, or has he confused inference with fact?

Has he taken account of all the facts within the sphere of his observation?

Has he concentrated his attention upon the important facts?

Are his senses reliable, or has he confused imagination with perception?

TESTS OF DEDUCTION.

I. *Categorical.*

A. Is the process correct?

May the terms of the syllogism be resolved into three pairs identically corresponding, except as to distribution? (See definition of distribution in a preceding footnote p. 152).

Is at least one premise affirmative?

Is at least one premise general (does it begin with distributed term)?

Is the term which occurs twice in the premises (middle term) distributed at least once?

Do the terms of the conclusion include no more than the corresponding terms of the premises (is their distribution no wider)?

B. Are the premises true?

Is the minor self-evident, admitted, or established by proof?

Is the major evident, admitted, or established by proof? (The common fallacy in a major is that it is too broad or includes too much to be true; and its weakness may be discovered by applying the method of reductio ad absurdum, illustrated p. 151)

II. *Alternative.*

Does the major premise enumerate all possible alternatives?

Are these alternatives mutually exclusive?

GENERAL TESTS.

I. *For begging the question.*

Has the thesis not been assumed as part of the proof?

Has the thesis not been assumed to be true when the opposing evidence is equal to that in its favor?

Has no proposition been assumed to be true when it was neither evident, accepted, nor proved, and therefore was merely an assertion?

II. *For ignoring the question.*

Are the terms of the thesis fully understood in making the proof?

Are they used in their accepted meaning in the proof?

Are they used with the same meaning throughout the proof? If not, the fallacy is that of shifting ground.

Does the proof establish the thesis as a whole, and not a part of it only?

Conclusion of the brief. If the brief endures examination by these tests without betraying weakness at any point, it may be assumed that the making of it is at last well accomplished, and that it is ready for amplification. At the end of the amplification, it is customary to restate the main arguments of the brief, as a conclusion; but such a conclusion is not needed at the end of the brief proper, except as a matter of form, or unless the brief is very long and full of detail. If introduced, it will of course contain no new argument, but will restate concisely the main arguments, ending with a restatement of the thesis itself.

Application. But there is another type of conclusion, employed for special purposes, which contains, in addition to a summary of the preceding argument, what is known as an application of it; which aims to add persuasion to conviction, to secure action after having secured assent, to appeal to the will after appealing to the intellect. While this persuasive application is largely a matter of style and of the personality of the writer or speaker, and as such can not be taken account of in the brief, it may on its logical side be defined as a drawing of inferences from the thesis already proved; a making use of the thesis as a premise from which to derive additional conclusions; these conclusions relating to the necessity, desirability, or expediency of some general or specific personal action. This, the logical part of the process, may be indicated in the conclusion of the brief. For example, if the thesis is that capital punishment should be abolished, and if that thesis is well established in the brief proper, inferences may then be drawn that it should be abolished in the particular state in which resides the public addressed, at the particular time at which they are addressed or as soon as possible thereafter, that the public addressed should take immediate steps toward having it abolished, and that they should make use of certain specific means toward that end.

Nature of Process. The drawing of these inferences is usually a deductive process, either because the thesis includes all the inferences in its own wider meaning, or because a new major

premise is introduced, which with the thesis constitutes a syllogism leading to a new conclusion. These major premises used in persuasion are of certain definite types. One of them asserts that all men will do or desire to do their duty or duties religious, social, or personal; duties to God, fellowmen, and themselves. Another of a lower order is the proposition that all men will do that which advances their self-interest; and another of a still lower order is that all men will do that which gratifies passion or prejudice. The last of these can, of course, never be used except at the sacrifice of moral quality in the argument.

Illustration. An illustration of the process is this. If it has been proved that capital punishment should be abolished, which is probably the same thing as saying that it is a duty to abolish it, we may construct the following syllogism:

All men (including those addressed) will do their duty (using the necessary means).
It is a duty to abolish capital punishment.
You (some men, present) will (take steps to) abolish capital punishment.

Another syllogism or another stage in the reasoning will show what the necessary steps to be taken are; perhaps another will show what individuals are to take them, and so on.

If but one inference is drawn from the thesis, or if the several inferences are successive, each one proving the next, so that all constitute a chain leading up to a single important conclusion, the brief-maker should consider whether this single inference or important conclusion is not the real thesis of his argument, and his assumed thesis merely a special issue. In that case, his entire brief would require readjustment, and the necessity for a conclusion would disappear. But if the single inference or important conclusion touches a matter that the public might be unwilling to entertain before knowing the proof, or if it has reference to specific personal action, its conventional place is at the end of the brief. And if not one but several coordinate inferences are drawn from the thesis, these must necessarily be stated in the conclusion of the brief, since to substitute any one of them for the thesis would deprive all the others of a place in the argument.

Relation of amplification to brief. The office of the amplification generally stated is to define the terms used in the proof, to explain the propositions used in the proof, to explain the relations which make the proof effective, and to add, define, and explain supplementary proofs, perhaps of a lower degree of subordination than those stated in the brief. Ordinarily the thesis is stated at

the beginning of the amplification; but if it is a proposition which the public is likely to regard unfavorably before it has heard the proof, it is wise to state instead of it the question upon which it is based. Such a substitution of question for thesis would not be necessary or advisable in the brief.

Fundamental law of brief-making. Perhaps all the principles hitherto enunciated are summed up in the one fundamental law that the presentation of an argument, and therefore the underlying brief, should be as direct and simple as it can be made. The brief-maker should not be content with clearness and correctness, but should endeavor so to shape his argument that it may be as forcible as possible, and that it may lose none of its force in transmission.

Final illustration. To illustrate this final point, the main outline is given of a brief (Baker, Argumentation, p. 159) which is reasonably clear and correct, but which may be rearranged so as to secure greater directness and simplicity.*

OUTLINE OF BRIEF.

Should Boston adopt a system of underground or of elevated transit?

Introduction.

I. The following statements show that Boston's transit facilities are inadequate. (Statements follow).

II. Two facts prove that Boston greatly needs more rapid transit. (Facts stated).

III. The following conditions bear witness that surface cars can in no way give relief. (Conditions stated).

IV. Since rapid transit cannot be procured on the surface, the question is whether to go above, by an elevated road; or below ground, by a tunnel near the surface, or a deep tunnel (three alternatives).

Brief Proper. (Omitting sub-propositions).

P. The deep tunnel (Greathead) system should be adopted.
  I. Tunnels would not injure the city as would an elevated road, or a subway.
  II. Only deep tunnels would equally accommodate all districts.
  III. A system of tunnels would procure the most rapid transit.

Refutation.

I. A tunnel here would not have the defects of the London one.
II. People would not be deprived of pleasure rides.
III. Tunnels would not be disagreeably cold.
IV. Tunnels would not be badly ventilated.
V. Tunnels would not be financially impracticable.

Conclusion.

A Greathead deep tunnel is preferable to an elevated road or a subway.

Details are omitted for lack of space, but it appears from the introduction and conclusion that the purpose of the argument is to consider a certain number of alternatives. The question states but

*Such a rearrangement may do violence to the intent of the original, an intent which is of course best known to the maker of the original; but if it is possible to misconstrue a brief, that is of itself evidence that the brief is not an ideal one.

two, while the argument itself develops that there are four. One of these four is disposed of in the introduction, leaving three others to be considered. The brief proper, framed to show that one of these three is the one proper to be chosen, refers only indirectly to the other two, and leaves the impression that one of those two has practically been ignored until the conclusion assures the reader that this is not the case. The introduction seems to be as definitely argumentative as is the brief proper; though perhaps the material in it may be regarded as evident or admitted.

If the general intent of the argument is as indicated, the following suggested rearrangement of it will make that intent more unmistakable:

OUTLINE OF BRIEF, REARRANGED.

P. Boston should adopt the Greathead (deep tunnel) system of rapid transit.

Introduction.

(Apparently not necessary; but may include I following, if I is regarded as evident).

Brief Proper.

I. Boston must improve its present transit facilities (in some way, state alternatives).
   A. They are inadequate (sub-proofs).
   B. They are not sufficiently rapid (sub-proofs).

II. Of the four alternatives open, three are objectionable;
   A. Extension of surface car system can in no way give relief.
   B. Elevated roads will not answer the purpose (proof gathered from I, II and III of original brief proper).
   C. Subways near the surface will not answer the purpose (proof gathered as before).

III. The fourth alternative (deep tunnels) will answer the purpose.
   A. It is preferable to the others (aspects noted),
   B. The objections advanced do not hold (refutation; subordinate points as given in original brief).

Conclusion.

(Purely formal, or unnecessary).

This analysis resolves the entire brief into an alternative syllogism which after objecting to all but one of the possible alternatives, brings direct argument in support of that one. Almost all the material under the head of refutation in the original brief may be restated so as to constitute direct argument. The only material rearrangement in the order of details is that suggested under II in the revised brief, and this, because of the apparent confusion in the original, can hardly be avoided. The essential suggestion is that the argument shall be recognized as alternative reasoning, and definitely presented as such, when all parts of it fall at once into their places, though the precise order and method to be followed will vary with individual conceptions of the nature and weight of the materials.

Importance of broad analysis. If an argument be rightly analyzed and broadly grasped as a whole, and the logical structure of its main outline be made definite and unmistakable, minor difficulties in analysis and presentation are likely to disappear, the liability to error to be decreased, and the argument will become more convincing in direct proportion to the simplicity and directness of the brief.

Pronouns of Address in "the Idyls of the King."

BY W. H. CARRUTH.

English usage formerly permitted the application to a subject second person singular any of one of the pronouns 'thou,' 'ye,' 'you.' This usage is still familiar in poetry. 'You,' being properly the objective case of 'ye,' was not at first distinguished from 'ye,' but its use was a manifestation of a general tendency of the objective form to displace the nominative. But 'thou' was restricted to relations of greater intimacy, whether of endearment or contempt, when 'ye' and 'you' became the regular forms for respectful and polite address. The history of this usurpation has not been studied with sufficient care, but it does not belong to the present notes. The relation has been reversed in a measure, and I venture to say that the lofty style in poetry today favors 'thou,' using 'ye' but sparingly in the singular, and 'you' only as it declines toward the familiar and the commonplace.

The basis of distinction between 'thou' and 'you' being one of attitude partly, it is entirely proper to apply both pronouns to the same person, providing that the change go with a corresponding change in attitude. This change in attitude or relation has been formulated into verbal forms, as, in French, 'tutoyer,' in German 'duzen' and 'ihrzen,' and in English to 'thou' a person.

But whatever the shades of difference in relation implied by the different pronouns, it is generally regarded as inelegant or crude to use them indiscriminately. Inasmuch as the correct and consistent use of the thou-form with its agreements requires some practice and skill, it is quite generally regarded as a mark of the work of a beginner to undertake a poem in 'thou's' and fall into 'you's.' Teachers especially have their attention called to this by the efforts of students to use the thou-form in translating from classic literature. While many make the attempt, few are able to carry it through unless they have had some practice in verse writing. Indeed the greater number fail to feel the transition from one pronoun to the

other, or to recognize it as a solecism when their attention is called to it.

When the application of the plural form in address to one person was first coming into use one can easily understand how a writer might unconsciously drop from the artificial to the old and natural form, just as now untrained students do. But grammarians and rhetoricians point out an occasional instance of such a slip in Collins or Gray as illustration of the fact that almost any mistake may be found solitary in some good writer. In warning a student some time since against this rhetorical error I ventured to cite Tennyson, and especially in "The Idyls of the King,,' as a model in this point. I was fairly familiar with the Idyls, but having learned to distrust my general judgments I took an early opportunity of testing my opinion, with the result that follows.

In some of the first instances I have quoted passages, but as I found absolutely no ground for the shifts in most cases, I have contented myself later with giving the name of the speaker and the one spoken to, with an indication of the number of shifts. Where the sign "&c" occurs after a pronoun it indicates that a number of consistent applications of that form follow.

The summary of this examination is that Tennyson's pronoun scheme is for the

2ND PERSON,

	Sing.	Pl.
Nom:	thou, thyself, you, yourself, ye.	you, yourselves, ye.
Poss:	thy, thine, your, yours.	your, yours.
Obj:	thee, you.	you.

The examination shows *that these forms shift indifferently within the same speech and even the same sentence, in addressing one and the same person.* Verb agreement is always strictly observed.

The Coming of Arthur.

King Leodogran, message to King Arthur: Thou.

Arthur to Lancelot: Thou.

Lancelot to Arthur: Thou.

Arthur, message to Leodogran: Thou.

Leodogran to Chamberlain: Thou.

Leodogran to Ulfius and Bedevere: Ye, yourselves.

Bedevere to Leodogran: Ye, "Sir, for ye know that in King Uther's time," etc.

Leodogran to Queen Bellicent and her sons: Ye.

Bellicent to Leodogran: Thou.

Bellicent to Leodogran: "Be thou the king" (quoting Arthur's warriors to him).

Bellicent to Leodogran: Ye, "but turn the blade and ye shall see, and written in the speech *ye speak yourself*, 'Cast me away?'"

Bellicent (quoting Merlin to Arthur) "Take thou and strike."

Bellicent (quoting her mother to Bellicent) "O that ye had some brother, pretty one, to guard thee on the rough ways of the world."

Leodogran to Bellicent: Ye, thee, "ay and hear ye such a cry? But when did Arthur chance upon thee first?"

Bellicent to Leodogran: Thou, thee, "O King, I will tell thee true," and oft repeated.

Arthur to Guinevere: Thou.

Guinevere to Arthur: Thou, "King, and my lord, I love thee to the death."

Priest Dubric to Arthur: Thou, to Arthur and Guinevere: Ye.

Arthur to Roman ambassadors: Ye.

Gareth and Lynette.

Gareth to cataract: Thou.

Gareth (quoting Gawain to Gareth): Thou.

Gareth to his mother, Queen Bellicent: "Mother, tho' ye count me still the child," etc.

Bellicent to Gareth: Thou.

Gareth (quoting love to its ward): Thou.

Bellicent to Gareth: "Hast thou no pity upon my loneliness?"—(long speech, many thou's ending), "Stay, my best son, ye are yet more boy than man."

Gareth to Bellicent: Ye, you, "An ye hold me yet for child, How can ye keep me tethered to you?"

Bellicent to Gareth: "Wilt thou leave thine easeful bidding?"

Bellicent to Gareth: "Will ye walk thro' fire? Go, then, an ye must: only one proof before thou ask the King to make thee knight, of thine obedience and thy love to me, thy mother."

Bellicent to Gareth: Thou.

Gareth to Bellicent: Thou, "Thy son am I."

Old man to Gareth et al.: "Who be ye, my sons?"

Gareth to old man: "Your city; but tell thou these the truth."

Old man to Gareth: Thou, thee. "For an ye heard a music" (may be to all three).

Suppliant Widow to Arthur: Thou.

Arthur to Widow: "Whether would ye?" (may be family?) "Have thy pleasant field again."

Second Widor to Arthur: Thou.

Kay to Arthur: Thou.

Arthur to Second Widow: Thou. "Peace to thee, woman, with thy loves and hates."

Arthur to Knights: Ye; to messenger, thou.

Gareth to Arthur: "A boon, Sir King, for see ye not how weak and hungerworn I seem? Grant me to serve among thy kitchen knaves."

Arthur to Gareth: Thou.

Lancelot to Kay: Thou.

Kay to Lancelot: Thou, ye; "Think ye this fellow will poison the king's dish? but see thou to it, That thine own fineness," etc.

Gareth to Arthur: Thy.

Arthur to Gareth: Thou, thee, thy.

Gareth to Arthur: Thee. But, "of whom *ye* gave me to." Then: Thy.

Arthur to Gareth: "But wherefore would ye men should wonder at you?"

Arthur to Lancelot: Thou, thy, thou.

Lynette to Arthur: Thou. But, "Why sit ye there?" (may be to knights collective); thine.

Arthur to Lynette: Thyself, thy.

Lynette to Arthur: Thou, etc.

Arthur to Lynette: "Damsel, ye know this order lives to crush all wrongers of the realm."

Gareth to Arthur: Thou, thy, etc.

Lynette to Arthur (angry): Thee, thy, thou.

Kay to Servants: Your, ye.

Lancelot to Kay: Thou; but, "for that did never he whereon ye hail, but ever meekly served the king in thee."

Kay to Lancelot: "Ye are overfine to mar stout knaves with foolish courtesies."

Lynette to Gareth: Thou.

Kay to Gareth: Thou, thy, thee.

Gareth to Kay: Thee.

Gareth to Lynette: "Say whate'er ye will, damsel, but whatsoe'er ye say."

Strange Baron to Gareth: "Well that ye came. Good now, ye have saved my life; and fain would I reward thee worshipfully. What guerdon will ye?"

Gareth to Baron: Thou.

Baron to Gareth: "I well believe you be of Arthur's table."

Lynette to Gareth (in contempt): Thou, etc.

Baron to Gareth: Thou.

Gareth to Lynette: "Say thou thy say," etc.

Baron Morning-Star to Lynette: Thou, etc.

Lynette to Morning-Star: Thou.

Lynette to Gareth: "Wherefore stare ye so? Thou shakest in thy fear," etc.

Gareth to Lynette: Thou.

Morning-Star to Gareth: Thy.

Gareth to Morning-Star: Thou (dog) etc.

Gareth to Lynette: "Fair damsel, you should worship me the more;" thine.

Lynette to Gareth: "What knowest thou of flowers? What stick ye round the pasty? What knowest thou of bids? What dream ye when they utter forth May-music. (So runs thy fancy.) See thou have not now larded thy last," etc. "And so ye cleave his armor off him."

Evening-Star to Gareth (thinking it his brother): "O brother-star, why shine ye here so low? Thy ward is higher up: but have ye slain the damsel's champion?"

Lynette to Evening-Star: Thou.

Lynette to Gareth: Thou, thy (begging pardon).

Gareth to Lynette: "Damsel, you be not all to blame, saving that you mistrusted our good king." "You said your say." "Thy foul saying fought for me," etc.

Lynette to Gareth: "Know ye not these?" (after fall from Lancelot): "Why laugh ye? That ye blew your blast in vain?"

Lancelot to Gareth: Thou.

Gareth to Lancelot: Thou.

Lynette to Lancelot: "Why came ye not when called?"

Lynette to Gareth: "Knave, knight and prince and fool, I hate thee and forever."

Lancelot to Gareth: Thou.

Lancelot to Lynette: "O damsel, be you wise to call him shamed who is but overthrown?"

Lynette to Gareth (sleeping): Thou.

Lynette to Lancelot: Thou.

Lancelot to Lynette: "He you name."

Lynette to Gareth (tender): "I curse the tongue that reviled

thee; wonders ye have done; miracles ye cannot; I see thee maimed, mangled." Thou, etc.

Gareth to Lynette: "Damsel, tell me all ye know. You cannot scare me."

Gareth to Lancelot: Thee, thy.

Gareth to Knight Death: Thou, etc.

Geraint and Enid.

Geraint to Enid (angry): Thou. "Thy worst and meanest dress."

Geraint to Guinevere: "Like you."

Dwarf to Maiden: Thou.

Geraint to Guinevere: This insult, done in this maiden's person to yourself."

Guinevere to Geraint: You. "And may you light on all things that you love."

Geraint to Sparrowhawk's people: Your, ye.

Geraint to Yniol: "So that ye do not serve me sparrowhawks."

Yniol to Geraint: Yours, yourself (nom.). Ye.

Geraint to Yniol: Your, ye, yourself.

Yniol to Geraint: "Art thou he indeed? When first I saw you moving by me on the bridge, Felt ye were somewhat;" your, you, etc. Next speech: "Arms—at thine asking, Prince Geraint; but thou that hast no lady, canst not fight."

Geraint to Yniol: "Thy leave! Let me lay lance in rest for this dear child."

Yniol to his wife: "Go thou to rest."

Edyrn to his lady: Thee.

Edyrn to Lancelot: Thee, thou.

Lancelot to Edyrn: Thou.

Mother to Enid: "Look on it, child, and tell me if ye know it." You, ye, etc.

Enid to Mother: "Your good gift." Ye, you (obj.), you (nom.), yours, yourself (obj.), ye.

Geraint to Mother: Thy, "among you" (pl.), your, "Your fair child."

Geraint to Enid (reminiscent quotation of first speech above): Put on yoyr worst and meanest dress.

Geraint to Enid: Thee, thee.

Enid (in disgrace) to Geraint: You (obj.), your.

Geraint to Enid: Your, you (obj.), ye (nom.), yourself (nom.).

Enid to Geraint: You (nom.), you (obj.), "Larger limbed than you are, to fall upon you while ye pass."

Youth to Lancelot: Thou, you (nom.), your, thou, thee (all within a few lines).

Lancelot to Youth: Ye.

Geraint to Enid: Ye.

Limours to Geraint: "Your leave."

Limours to Enid: you (obj.), ye (sing.), your, (sing.) (father), you (nom. sing.), you, you and he.—ye (nom. pl.), "You do not speak to him."=you (obj.), your (sing.), you (obj.), ye (nom. sing.), thee.

Enid to Limours: You (nom.).

Geraint to Enid: Your.

Geraint to Host: "Thy reckoning! Ye will be all the wealthier."

Geraint to Enid: You (obj.), ye, ye, you (obj.), ye, you (obj.).

Enid to Geraint: You (nom.), your, you (obj.).

Geraint to Enid (mollified partly): Ye, you, "Then do thou,—pray that we meet the horsemen of Earl Doorm."

Doorm to Enid: Ye, you (obj.), your, etc.

Enid to Doorm: You (obj.), etc.

Geraint (repentant) to Enid: You (obj.), you, you (nom.).

Enid to Geraint: You (obj.), your.

Enid to Edyrn: You (obj.).

Edyrn to Geraint: You (obj.), you (nom.), ye (pl,).

Edyrn to Enid: You (nom.), yourself (nom.), you (obj.), etc.

Arthur to Geraint: Ye, your, etc.

Balin and Balan.

King Arthur to his treasurer: Thou.

The treasurer to Arthur: Thou.

Arthur to Balin and Balan: Ye.

Messenger to Balin and Balan: Ye.

Balin to Arthur: Thou.

Arthur to Balin: Thou.

Balan to Balin: Thou.

Guinevere to Lancelot: Thou. But "Ye stand, fair lord, as in a dream." Then: Thou,

Woodman to Balin: Thou.

Balin to Woodman: Thou.

Men of Pellam to Balin: Ye.

Garlon to Balin: Ye. But "Thou from Arthur's hall?" "Ye men of Arthur" (pl.).

Balin to Garlon: Thou.

Garlon to Balin: Ye. "What, wear ye still that same crown-scandalous?"

Balin to Garlon: Thou.

Balin to his shield (cognizance): Thou.

Vivien to Balin (unknown): Thou.

Balin to Vivien: Thou.

Vivien to her squire: Thou.

Guinevere to Lancelot (reported): Thou.

Vivien to Balin: Ye. "Sweet lord, ye do right well to whisper this." (Second line after): "But thou shalt go with me," etc.

Balan to Balin (unknown): Thou.

Squire to Vivien: "And, Vivien, tho' ye beat me like your dog, I, too, could die, as now I live, for thee."

Balan to Balin: "I that fain had died to save thy life, have brought thee to thy death." "Why had ye not the shield I know?"

Stranger to Balan (reported): Thou.

Balin to Balan: Thou.

Vivien.

Vivien to Merlin: You (nom.), ye (nom.), etc.; all, save: "I sit and gather honey, yet methinks, Thy tongue has tript a little: ask thyself." Then resumes: Ye, you, etc. "Was he like to thee?"

Merlin to Vivien: Ye, you, etc., all through; save the response to the above *thy*. "Thou read the book, my pretty Vivien! Thou read the book? Ask no more: For though you should not prove it on me, But keep that oath ye sware," etc.

Merlin, apostrophe to Arthur: Thine, thy. After this, love passages from both in ye, you, etc. Vivien: "There must be now no passages of love between us," etc. Your, you, etc., but at the end: "My fate—must be to love thee still." Thee, thy. Then comes lightning, and

Vivien to Merlin: "Tho' *you* do not love me, save."

Lancelot and Elaine.

Arthur to Guinevere: You (nom.), ye, etc.

Guinevere to Arthur: Ye.

Guinevere to Lancelot: Ye, yours,—you (nom.), your, ye, your.

Lancelot to Guinevere: Ye, yourself (nom.).

The Lord of Astolat to Lancelot: Thou, ye.

Lancelot to Astolat: ye (pl), you (nom.).

Sir Torre to Lancelot: Ye.

Lancelot to Lavaine: You (nom.), etc.
Elaine to Lancelot (sotto voce): Yourself, (open) you, your.
Lavaine to Elaine: Your, you (obj.).
Knights to Lancelot: Thy.
Arthur to Gawain: You (nom.), you, ye.
Arthur to Guinevere: You (nom.).
Guinevere to Arthur: You, your, ye.
Arthur to Guinevere: Thee.
Guinevere to Arthur: Thy.
Elaine to Gawain: You, your.
Gawain to Elaine: Your, ye, you (nom.), ye (nom.), etc.
Elaine to Father: You, your, etc.
Father to Elaine: Ye, you (nom.).
Lavaine to Elaine and Torre: Ye.
Elaine to Lancelot: Your, you.
Lancelot to Elaine: You, ye, your, etc.
Astolat to Lancelot: Ye.
Brothers to Elaine: Thee.
Elaine to Brothers: Ye, your.
Elaine to Torre: Yourself.
Elaine to Father: You (obj.), you (nom.), ye, etc.
Lancelot to Guinevere: You (nom.), your, you (obj.), etc.
Guinevere to Lancelot: You, your.
Elaine (letter) to Lancelot: You (nom.), you (obj.), thou, etc.
Lancelot to the Court: Ye.
Guinevere to Lancelot: Ye.
Arthur to Lancelot: Thy, thou, thee, etc.
Lancelot to Arthur: You (nom.).
Lancelot (apostr.) to Elaine: Ye, thy.
Lancelot to Guinevere: Your.

Holy Grail.

Ambrosius to Percivale: Thee; thou; ye (pl.), you (pl. obj.).
Monk to Percivale's sister: Thy.
Sister to Percivale: Thou, thy, thee.
Arthur to Galahad: Thou, thee.
Percivale's sister to Galahad: Thou, thee.
Percivale to Ambrosius: You.
Arthur to Knights: Ye, you (nom.), ye.
Percivale to Arthur: Thyself (nom.), thou.
Arthur to Percivale: Thou.
Arthur to Galahad: Thou, thee, thy.

Hermit to Percivale: Thou, thyself.
Galahad to Percivale: Thy, thou.
Ambrosius to Percivale: Thee, ye, your.
Percivale to Ambrosius: Thou, thee.
People to Percivale: Thou, thee.
Ambrosius to Percivale: Ye, thee, thine, ye, your.
Bors to Percivale: Thou.
Bors to Lancelot: Thou.
Ambrosius to Percivale: Ye, your.
Arthur to Percivale: Thine, thee, thou.
Percivale to Ambrosius: Thyself (nom.), thee.
Arthur to Gawain: Thee, thyself.
Arthur to Bors: Thou.
Arthur to Lancelot: Thou, thee.
Lancelot to Arthur: Thine, thy (ye).
Voice to Lancelot: Thou, thee.
Gawain to Arthur: Thine.
Gawain to Percivale: Thy, thou.
Arthur to Gawain: Thyself (obj.).
Arthur to Knights: Ye, you (obj.), ye.
Arthur to Lancelot: Thou.

Pelleas and Etarre.

Pelleas to Arthur: Thy.
Pelleas to ideal maid: Thou, thee, thine.
Etarre to Pelleas: Ye, thou, thee.
Pelleas to Etarre: Ye, you (may be pl.), thou.
Guinevere to Etarre: Thee.
Etarre to Guinevere: Ye, your.
Etarre to her maids: Ye, yourselves.
Etarre to her men: You, ye, yourselves.
Pelleas to Etarre: Thy, thou, thyself.
Etarre to Pelleas: Thou.
Gawain to Pelleas: Thy, thou, thee; your, ye, thee, thy.
Pelleas to Etarre (disenchanted): You (obj.), your, ye, yourself.
Pelleas to Gawain: Thou.
Damsels to Gawain (supposing it Pelleas): Thee.
Gawain to Damsels: Ye, you (obj.).
Damsels to Etarre: Ye.
Gawain to Etarre: Your, you (nom.), ye, you (obj.).
Pelleas to Gawain and Etarre: Ye, your.
Pelleas to Travers etc (apostrophe): Your, you (obj.).

Etarre to Gawain: Thou, thyself.
Percivale to Pelleas: Thou.
Pelleas to Knights ("rats"): Ye.
Lancelot to Pelleas: Thou, thy.
Pelleas to Lancelot: Thou.
Guinevere to Lancelot and Pelleos: Ye.
Guinevere to Pelleas: Thou, thee, thy.

Last Tournament.

Tristram to Dagonet: Ye.
Guinevere to Arthur: Thou.
Arthur to Guinevere: Thine, thy, ye, thee.
Guinevere to Arthur: You (nom.), ye (nom.), thy.
Arthur to Churl: Thy, thee.
Churl to Arthur: Thy.
Red Knight to Churl: Thou.
Arthur to Kay: Thou.
Arthur to Knights: Your.
Arthur to Lancelot: Thou.
Lancelot to Tristram: Thou.
Tristram to Lancelot: Thy, thou.
Fool to Tristram: Thou, thy.
Tristram to Fool: Thy, thou, thy; ye, thy, thee, etc.
Fool to Tristram (familiar): Ye, thou. thy, ye, thou.
Tristram to Fool: Thy, ye, thy.
Fool to Tristram: Thou, thine, thyself, ye, ye (perhaps pl. but), you (nom.), "Do you see it."
Red Knight to Arthur: Thee, thou, thine.
Tristram to lone woman: Ye, thou, thy, thee.
Isolt to Tristram: Thou, thee, ye, thou, thee.
Tristram to Isolt: Thy, thine.
Isolt to Tristram: Thou, ye (pl.), thine, thee, ye (sing.).
Tristram to Isolt: Thine, thy, ye, thy.
Isolt to Tristram: Thou, thy, thee.
Tristram to Isolt: Thee, thou, you (nom.), ye, thee.
Isolt to Tristram: Thou, thy, thee, thyself, ye, etc., thou, etc.
Tristram to Isolt: Thee, thine.
Fool to Arthur: Thy, thee.

Guinevere.

Lancelot to Guinevere: Thee.
Guinevere to Lancelot: Thee, thou.

Modred to Lancelot: Ye (pl.).
Guinevere to Sisters: Ye, You (obj.).
Guinevere to Novice: Ye, thou, thy, etc.
Novice to Guinevere: You, your, you (consistent).
Arthur to Guinevere: Thou, thee (consistent).
Guinevere to Arthur (apostrophe): Thou, thee, thy.
Guinevere to Sisters: Ye, you (nom.), You (obj.), your.

The Passing of Arthur.

Arthur to Bedivere: Thou (consistent).
Bedivere to Arthur: Thou (consistent).
Gawain's Ghost to Arthur: Thou, thee.

Taxation in Kansas.

BY F. W. BLACKMAR.

PART I.

There is no politico-eonomic question of more vital importance to the people than that of the assessment and collection of taxes and the administration of the expenditures of government. In the whole realm of political life there is no greater opportunity for the institution of a needed reform than in a complete reorganization of the methods of taxation now in vogue. Thoughtful people who are interested in public justice have observed this lo, these many years, and many writers have advocated salutary changes. But the people through their legislative representatives are slow to move in this direction, partly on account of the prevailing sentiment that a tax is a necessary evil, and to grumble about it has become chronic, those doing the largest amount of grumbling being frequently those who have the least reason to complain. Again the subject of reform in taxation is a great one and imperfect methods of legislation find no opportunity to successfully make the necessary changes.

Successful legislation is at best a very difficult thing, and a complicated institution like our tax system which has grown by degrees and taken deep root in our political system is difficult to change. Beginning with the old general property tax which was supposed to cover every kind of property, various laws have been enacted from time to time to cover new forms of property as they arose under a changing economic system. The rule has been, "wherever property comes in sight tax it." Without a careful study of the incidence of taxation this has led to double taxation, imperfect assessments and to the development of the art of tax-dodging, until now the only hope of salutary change is not under the impulsive action of a legislature through a single law, but by a commission of experts and statesmen who shall develop a scientifically correct and thoroughly practical system. Even then there would be danger of such a system failing through the im-

patience of the people, for it would take several years for such a system to go into successful operation.

There are several distinct groups of people urging modern tax reform. Many of these are mere enthusiasts who see only the evils of the modern system, and who are unable to trace their true cause and much less able to suggest the best means of reform. Men like the late Henry George and his followers have been enthusiastic, almost fanatical tax reformers. As agitators they have performed a great service. While they have been unable to locate specifically the real trouble they have in a general way pointed out directly and emphatically the evil results of an imperfect system. Without a true and complete diagnosis of the case they have offered an unsafe and inadequate remedy.

Another group of reformers represented by the New York Tax Reform Association have also done good work by way of agitation of certain reforms in the tax system of the United States. More liberal in their views than the followers of the single tax advocate they are not less radical in their position. They have done well to present for the consideration of thoughtful people a platform which involves the principles which they advocate. While this platform indicates something of commercialism on the one hand and of doctrinarianism on the other the cardinal points of their platform are founded on right principles. Their concluding paragraph is commendable, namely, "We desire to unite our efforts to keep up intelligent discussion and agitation of the subject of taxation with a view to improvement in the system and enlightenment as to the correct principles."

But perhaps the most useful of modern movements is that of certain scholars who have been carrying on especial investigation into the actual condition of taxation in the United States and presenting and applying anew the principles of taxation so long ago advocated by Adam Smith and his imitating followers. Among these may be mentioned R. T. Ely's work on Taxation in American States and Cities; E. R. A. Seligman's Essays on Taxation; E. H. Noble's Taxation in Iowa; The Reports of the Illinois Bureau of Labor Statistics on Taxation in Illinois; Carl Plehn's General Property Tax in California. These have done much to acquaint the people with a true state of the case, and to present the principles of taxation as they have not been presented before in this country, although taxation has been scientifically treated by scholars and statesmen of the old world for over a century.

It is to be hoped that this study of Taxation in Kansas may be

an addition to the series of thorough investigations into the conditions and principles of taxation in Kansas, and that finally the work of the agitator, the dogmatism of the doctrinaire and the investigation of the scholar may be followed by wise legislation of the statesman and by the aroused political conscience of suffering people willing to support a system of taxation established in their own interest.

Taxation in Kansas is not widely different from taxation in other states and the good and evil conditions represented here will be found with some variation in nearly all of the states of the Union. This paper therefore proposes to work out the problem as it exists within a definite political and geographical territory. And the first purpose is to acquaint ourselves with the machinery of taxation, subsequently to inquire into the results of its operation and finally to suggest needed changes.

THE TAX LEVY.

The legislature at each regular session estimates the amount of tax to be raised and passes a law providing a levy for the revenue for two succeeding years. The rate of this levy is based upon the assessment of the preceding year. The act must state the rate in mills on each dollar of assessed property necessary to meet all expenses of the government. The state board of equalization after the completion of the assessment by the counties, changes the assessments when necessary to make the total valuation such as to yield the amount required for state purposes according to the rate fixed by the legislature. The board of equalization levy a rate for the support of the State University sufficient to raise the amount appropriated by the legislature for that purpose. Subsequently the state auditor determines upon the basis of equalized valuation the amount of tax necessary for each county to raise for state purposes and certifies the same to the county clerk. The clerk of each county then estimates the rate that must be levied on the original assessment in his county in order to yield the required amount. When the assessment for each year is completed the commissioners in each county levy the county tax, the council in each city levy the city tax, the trustee in each township levies the township tax, the school districts and school boards in cities of the first and second class levy the school tax, and the rate in each case is certified by the proper officer to the county clerk before the 25th of August. Thus the levy is for state, county fund, city fund and educational fund in cities, and outside of cities, township and school district are to be substituted for city and school board funds.

The county clerk now determines the amount of taxes for each property owner, which is set down opposite his name on the roll, which when completed is turned over to the county treasurer. This completes the work of the tax levy for the general property tax.

ASSESSMENT.

The aim is to assess every kind of property in Kansas and to assess it but once. To this end property is divided into two classes—personal and real. The later includes by the enumeration law, "the land itself, * * * all buildings, fixtures, improvements, mines, minerals, quarries, mineral springs and wells, rights and privileges appertaining thereto." "The term 'personal propesty' shall include every tangible thing which is the subject of ownership, not forming part or parcel of real property; also all tax-sale certificates, judgments, notes, bonds and mortgages, and all evidences of debt secured by lien on real estate; also the capital stock, undivided profits, and all other assets of every company, incorporated or unincorporated, and every share or interest in such stock, profits or assets by whatever name the same may be designated." The law then proceeds to show that the property of companies must not be included in other personal property subject to taxation or listed as the property of individuals and concludes that "the words 'personal property,' when used in this act in their general sense, shall include all taxable property other than real property."

The list of exemptions is quite large including "all buildings used exclusively as places of worship, or as public school houses, or both, with the furniture and books therein contained and used exclusively for the accommodation of schools and religious meetings, together with the grounds owned thereby, not exceeding in any one case ten acres if not leased or otherwise used with a view to profit, and also any parsonage or dwelling owned by any church society and occupied by its pastor as a residence, together with the grounds on which it is situated, not exceeding in any one case one-half of an acre. *Second*, all lands used exclusively as graveyards. *Third*, all buildings and parts of buildings belonging to scientific, literary and benevolent associations, used exclusively for scientific, literary or benevolent purposes, together with lands not exceeding five acres, occupied by such institutions and attached thereto, if not leased or otherwise used with a view to profit, and all books, papers, furniture, apparatus and instruments belonging to such associations and used exclusively for scientific, literary and

benevolent purposes. *Fourth*, all moneys and credits belonging exclusively to universities, colleges, academies or public schools of any kind or to religious, literary, scientific or benevolent and charitable institutions or associations, not exceeding in amount or in income arising therefrom the limit prescribed by the charter of such institution or association. *Fifth*, all property belonging exclusively to this state or to the United States. *Sixth*, all property belonging exclusively to any county, city, town or school district, except land bid off for counties or cities at tax sales. *Seventh*, all works, machinery and fixtures belonging to and owned by any town, city or village and used exclusively for conveying water to such town, city or village. *Eighth*, all fire engines and other implements used for the extinguishment of fires, with the building used exclusively for the safe keeping thereof and for the meeting of fire companies whether belonging to any town, city or village or to any fire company organized therein. *Ninth*, personal property to the amount of two hundred dollars for each family. *Tenth*, the wearing apparel of every person. *Eleventh*, all public libraries. *Twelfth*, family libraries and school books of every person and family not exceeding in value in any one case of fifty dollars."

The officers for the assessment of property consist of the trustee of each township, and of a city assessor appointed by the city council in cities of the first and second class. Assessment then becomes a local matter and valuations are consequently made in local interests. Each assessor shall make out from such sources as he has at command a description of each piece of property listed and assess the same at its value in money. This basis of assessment is fixed by the township and city assessors meeting at their respective county seats on the first Monday of March of each year, and agreeing on an equal basis or valuation of property. The assessors call upon each person, company or corporation between the first day of March and the first day of May and secure a list of the personal property given and sworn to under oath. Each person is obliged to subscribe to the following oath:

"I do solemnly swear that in the above statement I have truly set forth all personal property, which, by law, I was required to list, either on my own account or in behalf of others, according to the best of my knowledge."

The list of articles must be given according to the following enumeration:

(1) Horses, six months old and over; (2) neat cattle, six months old and over; (3) mules and asses, six months old and over; (4)

sheep, six months old and over; (5) hogs, six months old and over; (6) goats, six months old and over; (7) farming implements; (8) wagons; (9) pleasure carriages, of every description; (10) gold watches; (11) silver watches; (12) plate and jewelry; (13) piano-fortes; (14) other musical instruments; (15) all interests on bonds of the U. S.; (16) all bonds and interest on bonds of any state, county, district or municipality; (17) all other bonds not exempt from taxation; (18) stocks in any company or corporation; (19) moneys; (20) credits $........., legal deductions $........., balance taxable; (21) average value of merchant's stock for the preceding year; (22) average value of merchant's moneys and credits for preceding year; (23) average value of manufacturer's stock for preceding year; (24) average value of manufacturer's moneys and credits for preceding year; aggregate value of all other personal property.

Ample provision is made for boards of equalization to regulate assessments and adjust claims as nearly as possible on a basis of justice. The board of county commissioners is a county board of equalization, which convenes the first Monday in June to equalize the assessed value in the county. They may raise or lower the assessment of personal property. They shall raise or lower the assessed valuation of real estate when it is respectively less or greater than its real value. Tax-payers may appear before the board to urge a reduction in the assessed valuation of their property. The state board of equalization, consisting of secretary of state, state auditor, and state treasurer, meet at the state capitol on the first Wednesday in July. They proceed to equalize the assessments of the several counties, raising it in some and lowering it in others.

COLLECTION.

As soon as the county treasurer shall have received the tax roll as completed from the county clerk, he shall enter the respective amounts opposite the described property and publish in a paper the amount of taxes charged for the state, county, township, school, city, or other purposes for that year, on each $100 valuation.

THE GENERAL PROPERTY TAX.

The general property tax is a very old institution, so old that it is obsolete in nearly every nation. The principal nations of Europe have long since abandoned it. It was practiced by the American colonies and the states of the new nation made it the formal basis of their revenue system. Many abuses have crept in under the system, which it seems difficult to eradicate.

PERSONAL PROPERTY TAX.

The most irregular tax is the personal property tax. Its chief difficulty is that so little of it is returned. It grows less each year in proportion to other taxes. The following table shows the assessed valuation of town lots, railroads and personal property from 1878 to 1896, inclusive:

TABLE I.

Year.	Land.	Personal Property.	Town Lots.	Railroads.
1878	$ 74,969,530	$25,606,163	$16,725,450	$15,532,163
1879	83,228,800	27,534,745	19,874,274	16,165,621
1880	87,510,028	31,921,835	20,922,021	20,547,702
1881	91,207,146	34,437,195	22,493,321	22,671,911
1882	96,741,025	38,087,359	26,203,733	25,086,156
1883	99,899,559	48,030,492	27,739,202	27,290,214
1884	117,325,342	56,890,513	34,836,990	28,460,905
1885	122,871,239	56,502,333	38,420,301	30,367,820
1886	142,668,463	55,491,779	46,967,259	32,453,776
1887	152,200,666	60,796,746	56,646,873	41,222,605
1888	168,558,547	56,441,763	73,862,136	52,829,664
1889	173,801,010	53,187,371	76,330,671	57,494,849
1890	168,285,199	48,750,913	72,814,873	57,866,232
1891	170,160,308	47,401,227	74,303,916	50,865,825
1892	171,167,129	46,315,463	65,317,432	51,404,544
1893	173,077,920	47,227,073	65,756,543	61,731,035
1894	173,075,265	40,854,934	61,835,141	59,764,683
1895	173,296,813	35,031,849	62,076,828	59,503,654
1896	166,623,312	36,156,224	59,043,785	59,333,155

Reference to this table shows that the increased valuation of land from 1878 to 1896 inclusive, is 122 per cent, of personal property, 41 per cent, of town lots 252 per cent, and of railways 282 per cent. The same is shown graphically by Plate I. It will be observed that in 1878 the personal property valuation was excessively low relatively to the land valuation and that it relatively decreased while land increased. In new countries the value of personal property is at first relatively high and subsequently the real estate gains on personal property. Then comes a period of wealth in which personal property gains rapidly on real estate. But in actual practice less personal property is returned each year while real estate being more tangible represents relative gains. The valuation of town lots shows the boom period of 1885 to 1889. Also the rapid increase in the valuation of railroad property from 1885 to 1889. Also the rapid increase in the valuation of railroad property from 1885 to 1891 is to be noticed. Under the title "land" are included all improvements on land, as the law requires that improvements and land shall be assessed together.

Worse discrepancies are found in other states than in Kansas. In California from 1880 to 1896 the increased assessed value of real estate was 135 per cent, that of personal property was only 8 per cent, but

this includes railroad property. It is true that in the beginning of a commonwealth, the personal property is larger in proportion to real estate than in later years, but this could not account for the vast difference. In New York the rate on real estate increased during the years 1875-1885 from $82\frac{79}{100}$ per cent to $88\frac{53}{100}$, while personal valuation decreased from $17\frac{21}{100}$ per cent to $11\frac{49}{100}$, or the amount of personal property decreased $74,044,160 in ten years, while real estate increased $801,995,515 in the same time. From 1873 to 1893 in Illinois the decrease in assessed valuation of land was 44.89 per cent, of personal property 49.42 per cent, of railroads 38.52 per cent, of city lots 7.54 per cent, and of corporations 74.33 per cent. This records a general decrease in the assessment of general property. It is asserted that Chicago property is assessed about 8 per cent of its actual value. The New York reports urge this against the general property tax. "A more unequal, unjust and partial system for taxation could not well be devised."

"The defects of our system are too glaring and operate too oppressively to be longer tolerated." "The burdens are so heavy and the inequalities so gross as to paralyze and dishearten the people." "The absolute inefficiency of the old and rickety statutes passed in bygone generations is patent to all." "The hope of obtaining satisfactory results from present broken, shattered, leaky laws is vain."

"The system is a farce, sham, humbug." "The present result is a travesty on our taxing system which aims to be equal and just."

"The general property tax is a reproach to the state, an outrage upon the people, a disgrace to the civilization of the nineteenth century, and worthy only of an age of mental and moral darkness and degradation when the only equal rights were those of the equal robber." If the following was appended to all of these selections: that the state of the political conscience in New York in respect to tax paying is evidence of moral darkness, the blackness of the system might be somewhat relieved.

Mr. Seligman says of this tax: "Practically, the general property tax as actually administered is beyond all doubt one of the worst taxes known to the civilized world. Because of its attempt to tax intangible as well as tangible things, it sinsagainst the cardinal rules of uniformity, of equality and of universality of taxation. It puts a premium on dishonesty and debauches the public conscience; it reduces deception to a system and makes a science of knavery; it presses hardest on those least able to pay; it imposes double taxation on one man and grants entire immunity to the next. In short,

the general property tax is so flagrantly inequitable that its retention can be explained only through ignorance or inertia. It is the cause of such crying injustice that its alteration or its abolition must become the battle cry of every statesman and reformer."

The small amount of personal property assessed, as represented in Table I and Diagram A, can be accounted for in no other way than that of the failure of tax-payers to return all of the property and of their influence in scaling down the values. While the law provides that the property owner shall list under oath all of his property and does not require him to fix the valuation, yet, in most instances, he fixes the value of the property either on his own responsibility or through the advice of the assessor. This is a difficult task, for if he desires to place a market value on household furniture it is an impossibility, for, as second-hand goods, their value is very low, there being no market for such in country places. Fearing lest he shall list them higher than his neighbor does his goods, or higher than the basis fixed by the board of assessors, he will scale down the price. If he is really dishonest and desires to dodge paying taxes he has an abundant opportunity. It is difficult to obtain the details of such examples, but the amount of deposits in banks before and after March first are rather suggestive, and the tendency to believe that a large number of mortgages actually belonging to people in the state are placed in the name of others outside the state, indicate, at least, a method by which the returns on personal property are relatively diminishing. It must be admitted that a large proportion of mortgages in Kansas are held by people outside the state, and as they become, in most instances, personal property in other places are exempted by custom, if not by law, from taxation in Kansas.

IRREGULARITY OF ASSESSMENT.

The law requires that all property shall be assessed at its full market value, and specifies that this valuation shall not be fixed at the price it would bring at forced sale. This is one of the most difficult points with which assessors must contend. In the first place, it is difficult to determine what is the true market value. This value varies in different localities, and local boards have various opinions as to valuation. The tendency is for each township or county to lower its assessment in order to escape a heavy burden of state taxes. Then, there is the pressure of individual influence to place a low valuation on property. The result is that assessment varies in adjoining states, counties, townships and in-

dividual properties are unequally assessed. The following items will illustrate some of the vagaries of assessment in Kansas in 1896. Thus, in Cowley county, real estate was assessed at twenty-five per cent of its full value, in Johnson county forty to fifty per cent, in McPherson county, forty per cent, in Reno from one-fourth to one-third, in Ottawa, land at $1.25 to $25 per acre, and other property at one-fourth actual value, in Dickinson, real estate at one-fourth actual value, in Salina county, land at one-third actual value. In the same year corn was assessed eighteen cents in Dickinson county, six in Geary, five in Morris, eight in Ottawa, fifteen in Wilson, four in Reno and ten in Johnson. Also, wheat in Wilson at forty-five cents, in Osborne at fifteen, in Ottawa at ten, in Dickinson at fifty, in Sumner at sixty, in Marshall at forty, and in Douglas at twenty cents. The variation in the valuation of corn is from four to twenty-four cents per bushel, that of wheat from ten to sixty. The variation in the valuation of cows being from $7 to $25 in the different counties. Nearly every county board of assessors has a different method of scheduling property. By some, live stock is especially classified, in others it is not. Some grade wheat, and corn, others do not. Some profess to assess the property at full value, but the valuation is not greater than in other counties, where assertion is made, that the property is assessed at half its actual value. Cowley county assessors fixed real estate at one-fifth of its actual value, and personal property at its full cash value.

In some counties the $200, exemption for each family is deducted from the actual cash value and the reduction of the remainder made. In others the $200 exemption is taken from the sum of assessed valuation. The State Board of Equalization can change the assessment made by the counties and thus more nearly approximate justice. In 1896 assessments were reduced in fifty-two counties from two to fifty-five per cent while assessments were increased in forty-five counties ranging from two to forty-five per cent. Even this method could scarcely overcome the discrepancy in assessment or do away with the injustice to citizens of the state by irregular assessment. So long as each county seeks to lower its assessment for the purpose of paying fewer taxes into the state treasury, inequality and injustice are liable to continue.

Editorial Notes.

A Brief German Grammar, by Professors Hjalmar Edgren and Laurence Fossler of the University of Nebraska, comes from the press of the American Book Company. The paradigms and rules of syntax are treated within the compass of ninety-eight pages, followed by exercises both in English and German occupying sixty-seven pages, the remaining fifteen pages being devoted to a brief vocabulary and an index. The grammatical presentation bears the stamp of Professor Edgren's strong personality, and contains fair and clear statements of many matters that fail of clear treatment commonly. The exercises are very good.

D. C. Heath & Co., publish a little volume in paper cover containing well chosen extracts from modern German writers for sight translation. On account of its convenient form and cheapness it will be found very welcome by German teachers. The compilation is the work of Miss Georgianna Mondan, of the Bridgeport High School.

In the series of Heath's English Classics, for use in secondary schools and in preparation for college there have recently appeared: De Quincey's Flight of a Tartar Tribe, edited by George A. Wauchope, of the University of Iowa, (30c), Coleridge's The Ancient Mariner, edited by Andrew J. George, of the Newton High School, (35c), Tennyson's Enoch Arden, Locksley Hall and Locksley Hall Sixty Years After, edited by Calvin S. Brown, (35c), and Shakespeare's The Tempest, edited by Frederick S. Boas, formerly of Baliol College, (40c). All of these are desirable works to have in this neat and handy form, and though edited by different hands the work in all has been done with an admirable subordination of erudition to the practical needs of young readers. The edition of The Tempest will be found especially welcome. The text of the Globe Edition has been subjected to the very gentlest expurgation, and the whole object of the brief but adequate Introduction is to win young readers to noble literature, not merely to sharpen their wits upon it.

